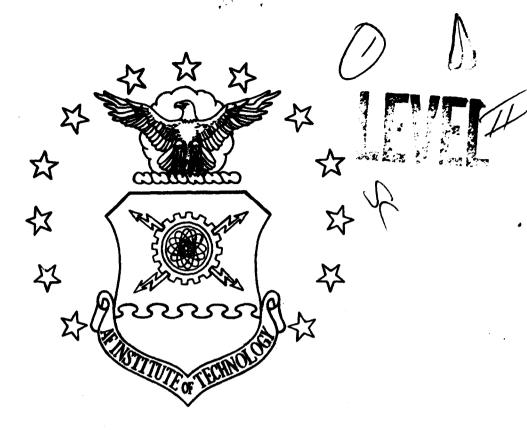
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AN ANALYSIS OF A ROUTING ALGORITHM FOR AUTODIN II ?

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AN ANALYSIS OF A BOUTING ALGORITHM
FOR AUTODIN II *

THESIS,

AFIT/GCS/EE/79-15 John A./Whittenton .

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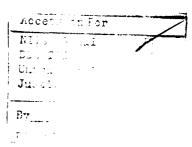
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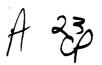
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John A. Whittenton Captain USAF

Graduate Computer Systems

December 1979





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Preface

Automatic Digital Netwrok II (AUTODIN II) has been a topic of major concern for two years. The Defense Communications Agency (DCA) contracted out to Western Union Telegraph Company the design and development of the AUTODIN II network configuration and systems engineering. As authorized through Western Union by DCA, Systems Control Incorporated (SCI) was contracted to develop a routing algorithm based on the Advanced Research Projects Agency Network (ARPANET) routing algorithm but tailored specifically to the AUTODIN II network.

In essence, this research project is a computer simulation of the SCI network routing algorithm to determine its characteristics and limitations under varying degrees of network configuration and system stress conditions.

I would like to express my thanks to Capt Wade L.

Neilson for his help in gathering the technical data on the algorithm. In addition, I want to express my sincere appreciation to Dr. Tom Hartrum and Capt Larry Kizer whose technical expertise proved invaluable. A very special thanks goes to my thesis advisor, Major Allen A. Ross, for his constructive advice, technical assistance and a sincere interest in the project from its conception to completion.

My deepest appreciation goes to my loving wife, Lorraine, whose moral support and sympathetic understanding indured me to continue throughout the course of the project.

John A. Whittenton

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Abstract

In computer communications systems, a network routing algorithm is the methodology behind which a message is directed (routed) from a source computer site, through the network of linked computers, to a destination computer site.

The simulation of such an algorithm is of extreme importance in determining the efficiency of the algorithm, its reaction response to network topology changes, and its system response as the network capacity of messages reaches the saturation point.

The algorithm to be simulated is hierarchical in nature, that is, with multiple processors at each computer site (node), the best route to the succeeding node is selected first, then a processor having a physical communications line (trunk) in the best route is selected. The connectivity of the network (how the nodes are connected to one another) and the amount of congestion at each node are vital parameters used by the algorithm in determining the best route.

The simulation language selected was General Purpose Simulation System (GPSS). It is an event oriented language readily adaptable to network queueing models. Entities called transactions are generated to simulate message segments (packets) which are then processed as a normal packet would be in a communications processor. Time delays are incurred by the transaction due to processing of the packet, wait time in queues and transmission delays (the time it takes to transmit the packet from one node to another).

The actual algorithm is written in FORTRAN. GPSS instruction blocks are used to jump from the GPSS code to the FORTRAN subroutines where the actual path is calculated that the packet will take to the next node.

A baseline program with static routing, that is, fixed routing that does not change, was first developed to establish a control program.

Four levels of input packet generation were used to vary the network loading from 60% to 90% of network trunk saturation. In addition to varying the traffic volume through the network, selected transmission trunks and links, and nodes were removed from the network to simulate varying topology changes.

AN ANALYSIS OF A ROUTING ALGORITHM FOR AUTODIN II

I Introduction

Background

A new computerized defense communications network, Automated Digital Network II (AUTODIN II), is currently being designed by the Defense Communications Agency (DCA). The new system is a result of increased user requirements on the current AUTODIN I network, additional independent military Automated Data Processing (ADP) systems requiring computer communications support, and projected computeroriented military information systems requesting entry into the World Wide Military Command and Control System (WWMCCS) Standard ADP System (Ref 1:1-1). In 1972, DCA began conducting a comprehensive study to identify current and future ADP requirements. The study concluded that by 1976 there would be approximately 250 computers involved in on-line communications functions with approximately 8,000 input/output terminals (Ref 1:1-1). Projections into the mid 1980's indicated that within the Department of Defense (DoD) there will be approximately 2,500 computers involved in communications with some 20,000 input/output terminals (Ref 1:1-1). The approach to AUTODIN II is start small (8 computer switching centers), meet the known validated requirements, and grow/evolve as requirements increase and

the needs for service change.

In June 1975 the Director, Telecommunications and Command and Control Systems (DTACCS), Office of the Secretary of Defense, gave initial program approval for AUTODIN II's development. The Request for Proposals was released to industry on 25 November 1975, with proposals due by 7 April 1976; final program approval was obtained in November 1976 with subsequent contract award to the Western Union Telegraph Company and its major subcontractors, Ford Aerospace and Communications Corporation and Computer Services Corporation (Ref 1:1-2). The Government issued the order to proceed with design and implementation of an initial four computer network on 14 January 1977 (Ref 1:1-2).

AUTODIN II is a digital, common-user, distributed communications computer network employing a message transmittal methodology called message packet-switching. A message is segmented into finite length segments called packets. Each packet contains all the essential information necessary for routing processes in addition to the actual data to be transmitted. The procedures or processes which direct (route) a message or packet from a source computer site through the network of linked computers, to a destination computer site are called routing algorithms.

Purpose/Problem

A routing algorithm has been developed by Systems

Control Incorporated similar to the one used by the Advanced Research Projects Agency Network (ARPANET) but with added refinements to tune it to the AUTCDIN II network. An algorithm developed for use in a highly sophisticated and complex network should be able to handle variations (spiked increases) in normal message volume with packets accumulating only minor additional delay time. It should also be able to detect any topological change or congestion occurring in the network and reroute the packet accordingly, with minimum additional delay in packet delivery. The purpose of this thesis is to determine the behavior characteristics of the routing algorithm under various simulated conditions involving the introduction of spikes in message volume and changes in network topology.

Scope

The content of this report is limited exclusively to the description, incorporation of the algorithm into the simulation model, and execution of the AUTODIN II routing algorithm. Detailed technical descriptions of other network system components are beyond the scope of this paper.

A network model is developed with a static (non-changing, deterministic) routing table as a control model.

The algorithm will then be incorporated into the network simulation model.

Organization

This report contains nine chapters. Chapter II begins

with a brief explanation of computer networks in general, then proceeds with a description of the AUTODIN II network architecture. Network topology, packet-switch center (node) decomposition, and network connectivity are also discussed. Chapter III describes the types of routing algorithms used in various computer networks. Chapter IV describes the developed hierarchical routing algorithm in detail. The six modules composing the algorithm and their interrelationships are discussed. The two modes of the algorithm, "Per Packet Functions" and "Background Functions" are also covered.

Chapter V discusses the simulation language, General Purpose Simulation System (GPSS), and the network simulation model. In Chapter VI, the baseline simulation model is developed with discussions on the static routing table, packet generation, source node traffic routing matrix and other essential baseline considerations.

Chapter VII deals with how the algorithm is incorporated into the network simulation model. Traffic volume changes and topological changes are also explained.

Chapter VIII discusses the results of the simulation with emphasis on packet delay analysis. In Chapter IX conclusions on the algorithm's adaptability to network changes and congestion, and any abnormal results are stated. Recommendations on possible changes or modifications to the algorithm or its documentation and any advisable network reconfigurations are also included in Chapter IX.

II The AUTODIN II Network

Basic Computer Networks

In general, a computer network is formed from the tying or linking together of two or more computers with their associated communications interfaces. The computers that process and direct messages or packets along to their destinations are called switching computers or nodes. The locations of the nodes can be geographically dispersed (that is, a site on the East Coast and a site on the West Coast), or locally connected (that is, intercity). Connecting the nodes together are physical data communications links called trunks. The trunks are made up of leased land lines, microwave links, satellite channels, or any combination of these.

Host computers and/or terminals are usually connected to the nodes. The network services the host computers and terminals by directing or routing the data messages to and from other host computers and terminals either connected to the same node or located at some other distant node. The primary purpose of the network is to permit access by a user, or by a process acting on behalf of the user, to resources of the host computers (Ref 2:48). The primary function of the network is to provide the medium through which the user's data messages are input from his equipment, properly routed to their destination node, and output to the destination's equipment. The network should be invisible to the users, providing only a virtual connection between

the user's input equipment and the Host computer the user is querying.

Network Description

The proposed AUTODIN II network is the result of several comprehensive communications computer requirements surveys (Ref 1:1-1). There are numerous existing and nearfuture computer systems employing various techniques for common-user communications between various military organizations. The surveys consolidated the different organizational requirements, near future and tentative computer systems requirements for communications computer support. The end result was the AUTODIN II network (Ref 3).

AUTODIN II is designed to provide economical and reliable data communications service both for interactive timesharing and transaction-oriented systems requiring rapid response between terminals and computer-to-computer data transfers requiring high transmission capacity (Ref 3).

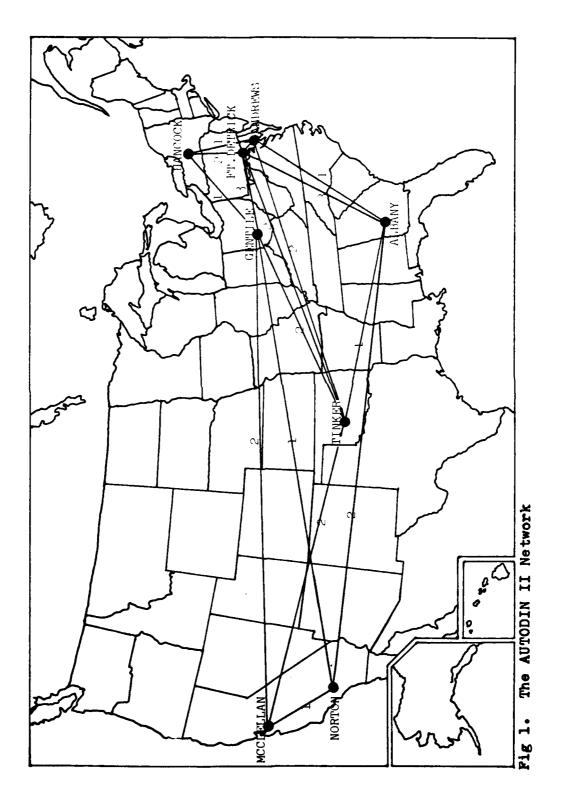
From the source or initial node, each packet is dynamically routed along one of several alternate paths, in some cases passing through one or more tandem nodes before arriving at the destination node. Unlike AUTODIN I which requires a message to be received in its entirety at a node before transmitting the message further, AUTODIN II provides the capability of routing simultaneously packets (containing part of the original message) independently of other packets of the same message thus propagating the message through the

network faster. If a message is made up of multiple packets, each packet can be routed independently of the other packets. Thus several packets can be propagated through the network at the same time, not necessarily using the same route to get to the destination node. If there are two separate paths to get to the destination, half the packets can be transmitted on one path, the other half being transmitted on the other path. In effect, the packets parallel each other in arriving at their destination node. A packet incurs a delay of only a very small fraction of a second at each node, so that the total delay, from the time a packet fully enters the initial node from the user (subscriber) until it begins to leave the destination node, shall be less than a second (Ref 3).

Network Architecture

Topology/Connectivity. The network is currently made up of eight packet-switching nodes (PSNs) located at Albany, GA; Andrews AFB, MD; Ft. Detrick, MD; Gentile AFS, OH; Hancock Field, NY; McClellan AFB, CA; Norton AFB, CA; and Tin-AFB, OK as Figure 1 depicts. The numbers in the figure represent how many trunks are contained in each link. These also are the sites of the current AUTODIN I network. The decision was made to colocate the two networks for ease of maintainability, cutover procedures, and obvious budget considerations.

The connectivity of the network is an important factor



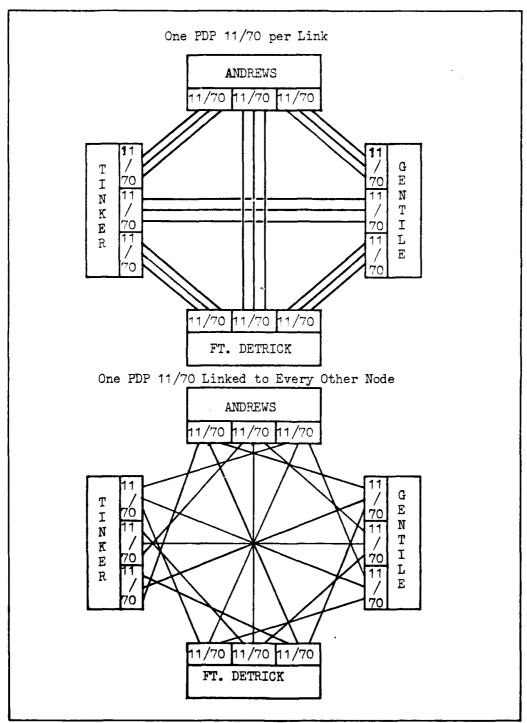
in the network. If each node in the network has three other nodes connected to it, then the connectivity of the network is defined to be 3.0. Unlike the ARPANET with connectivity 2.4 (2.4 nodes connect to each node), there are an average of four other nodes connecting each node in the AUTODIN II network representing a connectivity of 4.0. Packet wise, this means that there are fewer nodes, and therefore fewer links, for a packet to traverse in order to arrive at its destination node. The average number of hops (link traversals) a packet takes in the AUTODIN II network is .84, whereas in ARPANET it is 6 (Ref 3). The result of high network connectivity is less time delay from packet entry into the source node to delivery at the destination node. High network connectivity, as in the AUTODIN II network, means a packet requires fewer hops to get to its destination. With each hop, a packet incurs delay by having to be input processed by the receiving node and also by having to be retransmitted to the next node. The fewer hops a packet must make, the smaller the delay is at arriving at its destination.

Node Decomposition. Each packet-switching node (PSN) contains from one to three PDP 11/70 processors (Switch Control Modules (SCMs)), depending on the particular PSN's average traffic volume. Interconnecting the nodes are from three to five logical communications links. Each logical link contains from one to three physical transmission lines (trunks), again depending on the traffic volume of the site.

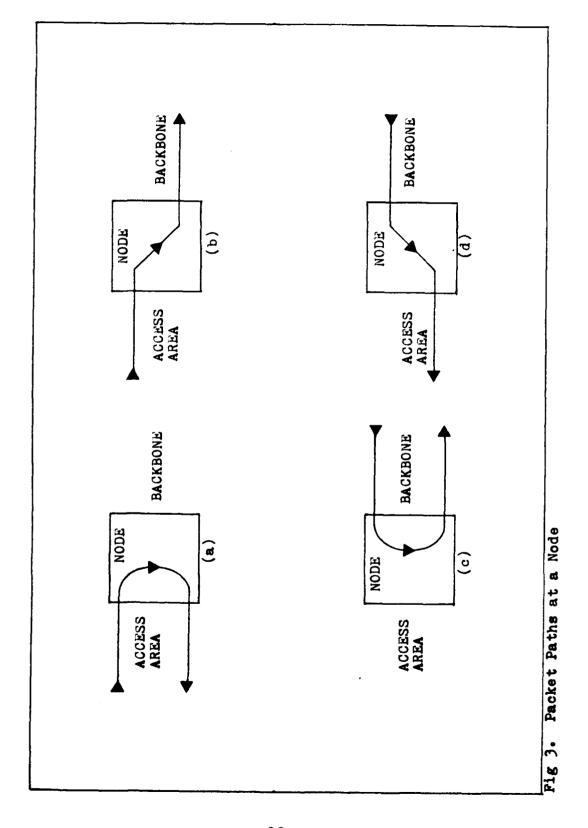
If all trunks of each PSN-PSN link were terminated on the same SCM, the routing of packets within the node could be done on a deterministic basis. However, in order to insure that the load is evenly distributed over SCMs at the node, to minimize dual processing required because of node connectivity, and to provide higher access to the available transmission bandwidth, the trunks for each link are distributed across SCMs at each node (Ref 4:25). This is shown in Figure 2 with the bottom figure representing the selected method of tying SCMs together. NOTE: This figure is for example only. Each node does not have three SCMs and the nodes are not totally connected in the real network. The example is shown to convey the idea of even trunk distribution.

into a node is called the access area. The term backbone pertains to the routing of packets solely between nodes. There are four basic paths for packets to take in the overall network system: (1) access area-to-access area, (2) access area-to-backbone, (3) backbone-to-backbone, and (4) backbone-to-access area. These paths are shown in Figure 3. In Figure 3a, packets enter the node from the access area, processed, and routed locally back to the access area. Figure 3b shows packets entering the node from the access area, being processed and routed to another node via the network backbone. Figure 3c depicts the path for packets entering the node from another node via the network

The connectivity of the Host computers and terminals



Pig 2. AUTODIN II Inter-Node Connectivity



backbone, processed and routed to another node via the backbone. In Figure 3d, packets enter the node via the backbone from another node, processed and routed to a local destination via the access area.

III An Overview of Routing Algorithms

The basic philosophy behind a message or packet routing function is the establishment of a continous path, usually incorporating several transmission lines (trunks) of a network, between any pair of source and destination nodes, along which messages are transmitted (Ref 5:213). The implementation of the route chosen consists of setting up, at each node along the path, a routing table that directs messages with a particular destination address to the appropriate outgoing trunk at the node. The table and associated table look-up procedures are incorporated in the memory and software of the computer at the node in question (Ref 5:213).

A fundamental element underlying all routing algorithms is the choice of the control ideology under which the algorithm is executed. The four most widely known and accepted ideologies are non-adaptive, centralized, isolated, and distributed (Ref 6).

Non-Adaptive Control

Non-adaptive or fixed algorithms are deterministic (static) in nature, that is, they do not adapt or change to take into consideration vacillations in traffic congestion or topological changes at the node. Rather, they are designed to provide satisfactory performance, on the average, over a range of traffic intensities (Ref 5:214). A message's path through the network is uniquely predetermined from

its source node to its destination node. Routing tables, predefined at each node, contain the path a message takes for any unique source-destination node pair. The routing algorithm generally used for this type of control ideology is called a shortest path type of algorithm. For each unique source-destination node pair, one path is generated. The path is broken into segments, each node in the path being responsible for routing the message over the particular segment it is in charge of. SITA, a cooperative company of international air carriers, has established a data communications network that employs this type of routing algorithm (Ref 5:28).

For the reader's information, AUTODIN I maintains static (fixed) routing tables. The entries to the routing tables are input one at a time, by hand-cut paper tape. A routing command/change is entered at the operator's console which reads the routing changes on the paper tape. An online utility program makes the correct changes to the routing tables. The routing table consists of primary, secondary, and in some cases tertiary routes. If the primary route for a message is disabled, an ALTROUTE (alternate route) command is entered from the operator's console which automatically establishes the secondary route as the primary route. When the disabling condition is corrected, a command is entered at the console which reestablishes the primary route.

Centralized Adaptive Control

Centralized adaptive algorithms utilize some kind of central supervisory program which dictates the routing decisions to the individual nodes in response to network changes (Ref 6). TYMNET, a computer-communications network developed in 1970, executes this class of routing algorithm. One example, the least-cost algorithm, as employed by TYMNET, is executed every time a user connects into the network and selects the route determined to be the least-cost for the user, then transmits this selected route to the nodes involved ahead of time (Ref 5:27). The routing algorithm, as contained in the supervisory program, finds the path of current least-cost, summed over the costs of each link on the path, from source computer to destination computer (Ref 5:27).

Isolated Adaptive Control

Isolated adaptive algorithms operate independently of other nodes in the network with each node making exclusive use of local data to adapt to changing conditions (Ref 6). The data usually contain parameters on source node, destination node, local trunk queue lengths, local topology, and message priority. From the data, a delay table and a routing table are formed. The delay time estimate entries in the delay table are the number of messages waiting in the queue on the particular outgoing link. The delay table is indexed by the destination node

and outgoing links. If a link connecting two nodes contain more than one trunk, the message with the highest priority is always routed on the trunk with the shortest queue. For non-priority messages, either trunk can be selected if the difference in the queue lengths is not greater than a set weighted bias. The bias can be adjusted to fit the needs of the node and the level of traffic volume. From the delay table, the link with the smallest delay is inserted in the routing table. The routing table is indexed by the destination node and in the case of a multi-trunk link, the trunks with the shortest and next shortest queues.

Distributed Adaptive Control

By far the most widely used and the subject of current state-of-the-art research, is the distributed adaptive routing algorithm. It utilizes internode cooperation and exchange of information to arrive at routing decisions (Ref 6). Several techniques are combined to make up this type of algorithm. First of all, the main feature of the algorithm involves the exchange of delay information between neighboring nodes. Whether the delay information is determined on estimated delay times to all the network nodes or just the delay to neighboring nodes, it is this information which the routing algorithm uses to update local routing tables at the node. Second, added to these delay estimates are local delay values based on the number of messages or packets on queue awaiting transmission on local trunks.

Third, these combined delays are compared against the current corresponding entries in the routing table and are substituted for the current entries if the new delays are less than the current delay. And fourth, the process of local decision routing becomes inherent in the algorithm by virtue of the fact that local queue lengths take an active part in the delay calculations. The ARPANET employs a version of this type of routing algorithm with delay status messages exchanged with neighboring nodes on the order of every 625 milliseconds (Ref 5:48).

The routing algorithm proposed for the AUTODIN II network is very similar to the ARPANET algorithm but contains four major differences. First, status information is exchanged between all network nodes rather than with neighboring nodes. Second, the information exchanged reflects local link congestion and/or local link connectivity status, that is, whether or not the link is up or down rather than the estimated delay to each of the other nodes. Third, the exchange rate of status packets is either periodical (every 400 milliseconds), event driven when link congestion occurs, or when a change in link status has been determined rather than set at every 625 milliseconds. And fourth, changes in the status of links or nodes which cause the generation of status packets produce a network topological table resident at each node making that node cognizant of the status of each of the other nodes in the network, whereas the ARPANET does not maintain a topological table at all.

IV <u>Hierarchical Routing Algorithm Description</u>

Chapter IV describes in detail the different tables generated and used by the routing algorithm. It also contains a detailed explanation of each module making up the algorithm. After reading Chapter IV, the reader should have a good grasp of how the algorithm builds and uses its various tables in order to arrive at the best trunk over which to route a packet to its appropriate destination. The reader should also have a feel of how each module fits into the overall operation of the algorithm.

The hierarchical routing algorithm is a distributed adaptive algorithm utilizing both status information exchanged between nodes in the network and local output queue lengths to determine the best path over which to route a packet. It derives its name from the two levels of routing procedures executed to determine the final trunk over which a packet is transmitted.

The unique quality requiring two levels of decision making is due to the presence of multiple (one to three) communications processors called Switch Control Modules (SCMs), located within each node of the network. At present, AUTODIN II is the only packet-switching network to employ multiple processors to handle the routing of packets through a network. Conditioned on predicted traffic volumes per site, one to three SCMs (PDP 11/70s) handle the routing decisions. Neighboring nodes connected by one

logical link but that link is made up of one to three physical transmission lines (trunks).

The first level of decision making selects the route or logical link over which the packet will be transmitted. The second level selects which SCM to use which, in effect, selects the individual trunk.

When a packet is received at a node, some process or set of processes must be executed to determine the next route the packet has to take to reach its final destination. The hierarchical routing algorithm is made up of such a set of processes to determine the best route for the packet to follow. The algorithm contains processes that maintain and update various tables in the algorithm's database used to calculate the best route. Route congestion or failure along with nodal congestion or failure are detected by the algorithm and compensated for by a recalculation of its database tables. Network awareness of the degradation is facillitated by the cognizant nodes formulating and transmitting status messages to the other nodes in the network. Upon reception of the status messages, a node uses the information in the status messages to recalculate its tables.

Due to the configuration of the trunk connections to the SCM(s), different routing results are obtainable. In one instance, a node contains one SCM and the selected link resulting from the execution of the algorithm contains multiple trunks. The trunk that has the shortest queue is

selected. In the case where the node contains multiple SCMs and the selected link is made up of only one trunk, the packet could incur additional delay required to switch the packet to the SCM that is connected to the correct trunk. That additional delay is not incurred if the SCM processing the packet is also the SCM to which that trunk is connected. In the situation where the node contains two SCMs and the selected link contains two trunks one connected to each of the SCMs, a bias factor is involved in the trunk selection because of the possibility of having to switch SCMs. If the packet is routed to a trunk on another SCM within the same node, information specifying which trunk queue is to be used goes along with it. Thus packets arriving at an SCM from another SCM within the same node can be queued directly for the correct trunks (Ref 7:9).

The operation of the routing algorithm can be summarized as follows (Ref 8:1-2):

- (1) Each node maintains a copy of the network topology.
- (2) Each node monitors its output trunk group queue, and compares them with a predetermined congestion threshold value.
- (3) Whenever the immediate connectivity of a node alters, or the congestion status of any of its trunk group alters, or on a periodical basis, the node transmits a connectivity/ congestion message to all other nodes.

- (4) On receipt of a connectivity/congestion message, each node updates its local copy of the
 network topology and updates its table of
 minimum-hop paths to all destinations.
- (5) Tandem nodes (nodes between the source and destination nodes) route packets by choosing only among the minimum-hop paths.
- (6) Source nodes route packets by choosing among the minimum-hop paths and the minimum-hop + 1 paths.
- (7) When a tandem node or source node has two or more paths to a destination, it chooses a specific output link by minimizing the combination of local queue delays plus bias representing the delay due to any reported congestion on the paths.

Algorithm Database

Each node operates with a copy of the algorithm. There are several tables and arrays calculated and maintained at each node by the algorithm. The tables are the Link Distance (LD) table and the Routing Distance (D) table. The LD table represents the nodal topology of the network. The AUTODIN II network is not a totally connected network, that is, each node is not connected to every other node. The LD table maintains which nodes are connected to which nodes along with the identification of congested links between nodes.

The D table contains, for each link a node maintains, the number of link traversals (hops) necessary to reach a given destination node.

The arrays the algorithm maintains and uses are the Connectivity Pointer (P) array, Connectivity Vector (NC) array, HOP array, LIST array, SROUTE array, and the ROUTE array. The P and NC arrays are interrelated arrays used in conjunction with other arrays to build the D table. The HOP array contains one entry per node in the network. Each entry is the number of hops required to get to the respective node from the local node. The LIST array also contains one entry per node in the network. Each entry is the respective node's ID number. The SROUTE and ROUTE arrays are used to select the link, given the packet destination node, over which to route the packet. SROUTE is used if the node is the originating node of the packet and ROUTE is used if the node is an intermediate node.

The Link Distance (LD) table is an N x N matrix where N is the number of nodes in the network, in this case eight. Nodes are numbered from one to eight in alphabetical order from Albany to Tinker. Source nodes correspond to row headings and destination nodes correspond to column headings. An entry in the table is a tri-state quantity reflecting either connectivity with no congestion, connectivity with congestion, or no connectivity. For example, let node i and node j be two nodes in the network. If there is a link between them and it is not congested,

the LD (i,j) entry is 1.0. If there is a link between the two nodes but it is congested beyond a set congestion threshold, the corresponding LD (i,j) entry is a 1.01. If the two nodes are not connected the LD (i,j) value is a pseudo infinity value (1000) which, in practice, is a very large number to preclude any packet from being queued to a non-existant link. Figure 4 is representative of the initial LD for the Andrews node.

The two arrays P and NC are interrelated arrays. The P array (connectivity pointer array), is an N+1 x 1 vector whose entries point to entries in the NC array. The NC array (connectivity vector) is an NL x 1 vector where NL is the number of one way links in the network, in this case thirty-two. The first NLN1 entries, where NLN1 is the number of links Albany maintains, are the numerical representations of the nodes connected to Albany. The next NLN2 entries, where NLN2 is the number of links Andrews maintains, are the numerical representations of the nodes connected to Andrews and so on for the rest of the nodes and their respective entries in the NC array. The entries of the P array point to the entry of the NC array that corresponds to the first link of a particular node. Figure 5 illustrates the contents of both the P and the NC arrays.

The HOP array is an N x l array whose entries correspond to the minimum number of hops required for a packet to reach a particular node. The source node's entry is a zero.

	•	 .e.	ALBANY 1	ANDREWS 1	H. DETRICK 3	GENTUE 4	HANEOCK S	MECLEUAN 6	NORTON 1	TINKER 8
	ALBANY	-	0001	-	-	0001	1000	•	_	^
	LNOREWS	7	~	0001	,	0001	,	0001	0001	1
	ANDREWS FI DETRICK GENTLLS			,	0001	,	,	1000	0001	_
	gentile	4	0001	0001	,	0001	,	,	,	'
	#4	2	0001	,	,	`	0001	0001	0001	0001
	Mecleuan	•	1000	0001	1000	,	0001	0001	,	`
	NORTON	,	_	0001	0001	,	1000	,	1 000	0001
.	TINKER	89	`	_	-	`	0001	-	0001	1 000

Fig 4. Initial LD Table for the Andrews Node

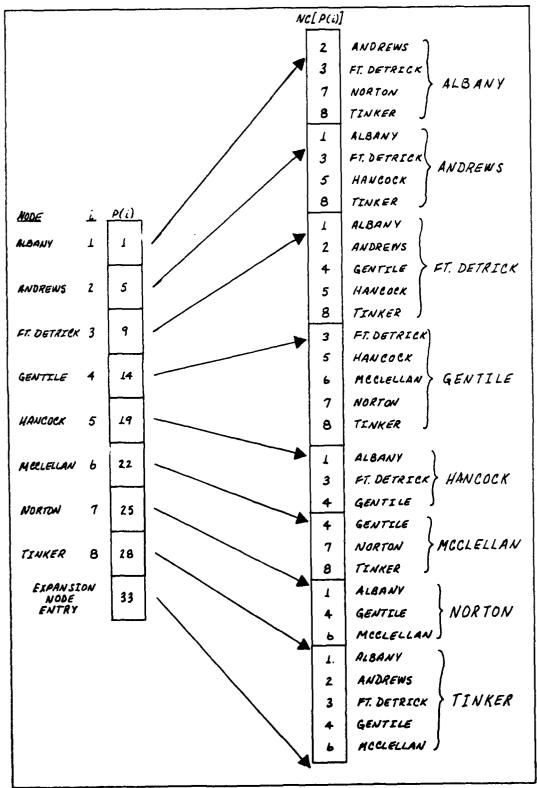


Fig 5. P and NC Arrays

Initially, the entries, except the source node entry, are either is or pseudo infinities, the is corresponding to directly connected nodes and the pseudo infinities corresponding to non-connecting nodes. Figure 6 shows both the initial HOP array and the revised version after initialization for the Andrews node.

The LIST array is an NL x l array. Each node is given a unique integer identification number from one to eight. The ID number is assigned in numerical order to the nodes arranged in alphabetical order, that is, Albany-1, Andrews-2, ..., Tinker-8. The first NLN entries, where NLN is the number of links a particular node maintains, are the numerical representations (ID numbers) of the nodes connected to the particular node executing the algorithm. They are basically taken from the NC array. The other N - NLN - 1 entries are the numerical representations of the nodes not connected. There is no entry for the source node. during the operation of the algorithm, a connected node's link drops out, that node's numer cal value is negated, removed from the set of connected node's value serted among the set of non-connected nodes. that link is flagged as being disconnected. Re. Figure 7 for the initial LIST array and the revised version after initialization for the Andrews node.

The LD table and the P, NC, HOP, and LIST arrays are combined to form the most important table the algorithm maintains, the D table (routing distance table). It is an

HOP(i)	HOPL
1 1	1 1
2 0	2 0
3 1	3 1
4 1000	4 2
5 1	5 1
6 1000	6 2
1 1000	7 2
8 1	8 1
B I INITIAL	8 Re

Fig 6. HOP Array for Andrews

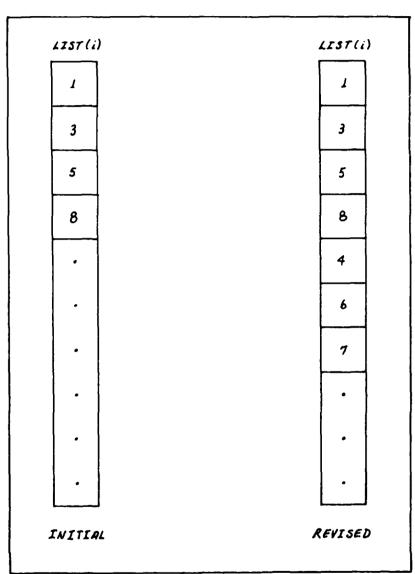


Fig 7. LIST Array for Andrews

N x NLN matrix, where again N is the number of nodes in the network and NLN is the number of links the node maintains. The entries reflect, for a given link, the number of hops (plus the congestion factor of .01 if congestion exists) required to reach a particular node. The table contains only minimum hop or minimum hop + 1 values. Minimum hop is defined as the least number of hops necessary for a packet to make, given the present node and the destination node. Minimum hop + 1 is just one more than minimum hop. Because a node is made up of multiple links, the number of hops a packet would be required to make on one link could be more or less than the packet would be required to make if routed on another link. If the number of hops required for a given link is more than the minimum hop + 1 count, that link's entry in the D table is the pseudo infinity value to preclude its usage in the routing calculations. of the D table gives the minimum hop/minimum congestion "distance" to a particular destination as a function of an outgoing link, such that only minimum hop and minimum hop + 1 paths have non-infinite values. Figure 8 shows the initial D table and the revised D table after initialization as calculated for the Andrews node. Note the initial values are similar to the constructs of the HOP array, that is, ls and pseudo infinities. The source node entries are set to Os for the set of outgoing links.

The SROUTE and ROUTE arrays are N x l arrays. An entry in either array represents the corresponding link to select,

2/1						
D(i, 1)					INK LI	
	NODE (i)	i	1	2	3	4
	ALBANY	1	1	1000	1000	1000
	ANDREWS	2	0	0		0
	FT. DETRICK	3	1000	1	1000	1000
	Gentile	4	1000	1000	1000	1000
	HANCOCK	5	1000	1000	1	1000
	MCCLELLAN	6	1000	1000	1000	1000
	NORTON	7	1000	1000	1000	1000
	TENKER	8	1000	1000	1000	1
D(i, 1)				OUTPUT	LINK (A)
	NODE (i)	غ		2	3	4
	ALBANY	1	1	2	1000	2
	ANDREWS	2	0	0	0	0
	FT. DETRICK	3	2	1	2	2
	GENTILE	4	3	2	2	2
	HANCOCK	5	1000	2	1	1000
	MOCLELLAN	6	3	3	3	2
	NORTON	1	2	3	3	3
	TEMKER	8	2	2	1000	1
			REV	ised D	TABLE	<u> </u>

Fig 8. D Tables for Andrews

given the destination node of the packet. If the node processing the packet is the source node, the SROUTE array is used for link selection. If the node is a tandem node (a node other than the source node or the destination node), the ROUTE array is used. The rationale behind having two link routing arrays is based on the idea that under normal operating conditions, a packet will encounter at the most only one tandem node because of the network connectivity. The source node could have multiple "best" routes to select from to get the packet to its destination, but a tandem node, in general, would have only one "best" route which would be the link directly connecting it to the destination node.

Modules of the Algorithm

The hierarchical routing algorithm is made up of six modules. They are PAKROUTE, MESGEN, UPDATE, RTABLE, TTABLE, and MINHOP. The overall organization of the hierarchical routing algorithm is shown in Figure 9. The box representing the UPDATE module includes the RTABLE and TTABLE modules. The purpose of the AUTHENTICATION blocks is to insure that only actual nodes (not users) can send an authentic network status message. Otherwise a malfunctioning or malicious user could bring down the network by declaring all links down (Ref 8:A-3). The "Background Functions" and "Per Packet Functions" are discussed later in this chapter. Table I should be consulted for definition of

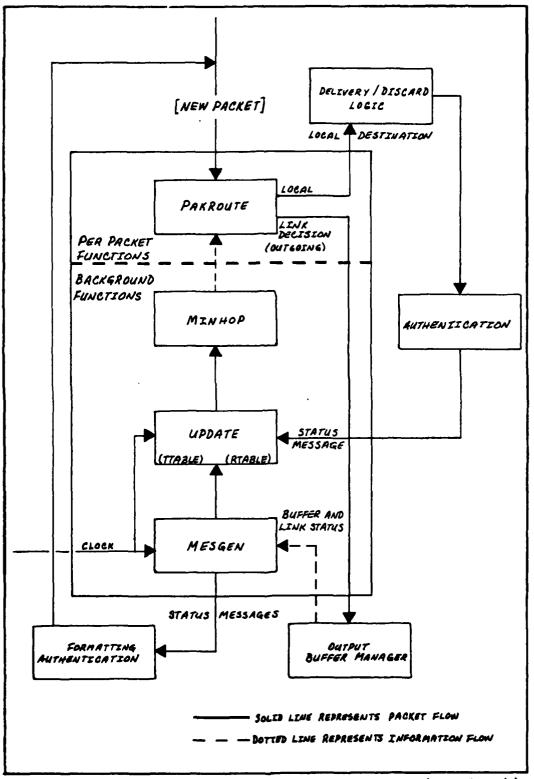


Fig 9. Overview of Routing Module

(Ref 8:A-4)

TABLE I Table of Variables

	Table of Variables	Nominal Value
NN	Number of nodes in the network	8
NL	Number of one-way links in the network	32
NLN	Number of links outgoing from a particular node	3-5
INF	Pseudo infinity number > maximum number of hops in network	1000
LD(i,j)	Link distance matrix NN X NN	INF,1,1.01
SELF	Node self ID number	1-8
D(i,j)	Routing Distance table NN X NLN	-
P(i)	Connectivity Pointer array, (NN+1) X 1	-
NC (i)	Connectivity vector, NL X 1	-
ROUTE(i)	Tandem node routing array (outgoing link ID number indexed by destination node)	-
HOP(i)	Hop count array, NN X 1	-
LIST(i)	Connectivity set array, NL X	1 -
BNOM	Congestion weight	7
CNOM	Extra hop weight	7
STAT(i)	Node report status array, NN X 1	INF,1,1.01
Tl	Congestion threshold (pkts per trunk)	7
T2	Saturation threshold (1,2,or SCMs) total number of packets in input queues	
TBUFF	Total number of packets in input queues	-
BUFF(i)	Number of packets queued on link i	-
LINES	Number of 56Kbps trunks serv: link i	ing 1-3
TABTICK	Time interval for running RT	ABLE 100 msec.

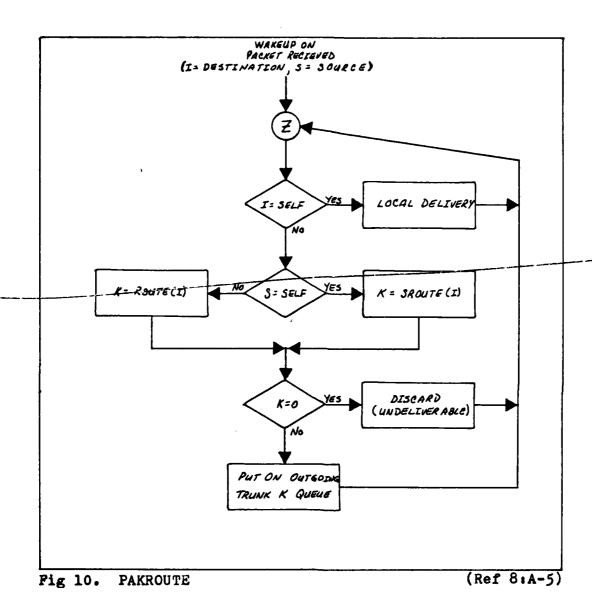
TABLE I (CONT'D)

		Nominal Value
FTICK	Time interval for "BAL" news detection in MESGEN	100 msec.
STICK	Time interval for "GOOD" news detection in MESGEN	400 msec.
SROUTE(i)	Source node routing array (outgoing link ID number indexed by destination node), NN X 1	-
ZONE	Flag denoting the status of the node on previous entry into MESGEN (0 - not saturated 1 - saturated)	0,1
BUP(i)	Previous status of link array, NLN X 1 (1 - link up, 1000 - link down)	1,1000

variables used in the following figures as the algorithm is explained. The symbol Z in the figures is used to denote a sleep or idle point for a procedure.

PAKROUTE. The module executed for every packet processed is PAKROUTE, Figure 10. Depending on the destination of a packet, a link is selected from the SROUTE or ROUTE array (processing node is the source or tandem node of the packet). When the link contains only one trunk, the packet is queued for output on that trunk. If the selected link contains more than one trunk, the trunk with the shortest output queue is selected.

MESGEN. MESGEN is described in Figure 11. The prime function of MESGEN is the generation, when necessary, of status packets containing the node's current connectivity or congestion changes. A link is declared congested whenever the queued packets/trunk for a link exceeds a threshold T1. A node is considered to be saturated whenever the total of all input queued packets exceeds a threshold T2. It is entered periodically at two different time intervals, FTICK (100 milliseconds) and STICK (400 milliseconds). When entered as a result of FTICK, "bad news" is checked. Links are checked to see if any have gone down since the last FTICK entry. Congestion on the individual links is also checked. If none of the links have gone down, or there is no congestion on any of the links, then node saturation is checked. If the saturation threshold is equalled or sur-



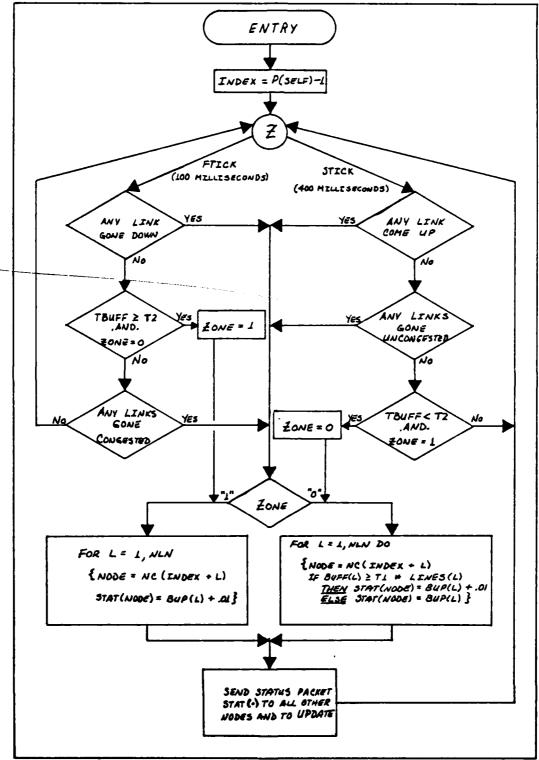


Fig 11. MESGEN

passed and the node was not saturated at the last FTICK entry (ZONE = 0), the node is considered saturated (Zone = 1), and a status message declaring all the node's links congested is formulated. If one or more links are down or congestion exists on one or more links a status packet is formulated selectively indicating congestion on the link or links in question. A copy of the status packet is sent to UPDATE for local processing. Copies of the status packet are also sent to other network nodes for their individual processing.

Upon entry because of the STICK time interval, "good news" is checked. Links are checked to see if any have come up as well as the absence of congestion on any of the links since the last STICK entry. If the status of the links are the same as the previous entry time interval, the saturation condition of the node is checked. If the node is currently not saturated and was saturated upon the last STICK entry into MESGEN (ZONE = 1), the node is considered not saturated (ZONE = 0). Even though the node is considered unsaturated, some links still might be congested, so they are checked individually for congestion in the event a link congestion status message is needed. If a link has come up or congestion no longer exists on a link, a status packet is generated by selectively checking each link. A copy of the status packet is sent to UPDATE for local processing. Additional copies are sent to other nodes for their processing.

Under entry into MESGEN because of FTICK or STICK, if

the processing gets down to check for the presence or absence of node saturation and the result of the check is negative, the module is exited with no further processing. Figure 11 is the corrected copy of the original module. An error was found during the code conversion to Fortran. The blocks explaining the actual entries into the status packet had been interchanged.

UPDATE. UPDATE is executed on each arrival of a status packet. As implemented in this simulation, for each pair of nodes, the LD table contains an entry indicating either the nodes are connected (1.00) and congested (1.01), or not connected (1000). Each arriving status message contains its source node's row of the LD table. The LD table is the table that is initially updated when a node receives a status message. The source node of the status packet encodes its corresponding row entries of the LD table and broadcasts it to the other nodes. Upon reception of the status message, the respective nodes compare the values in the status message against the appropriate row entry in their own LD table. If the values are the same the status message is discarded. If the values are different, the information in the status message replaces the corresponding row of the LD table. Figure 12 describes the procedure of UPDATE. It should be noted that the actual algorithm employs a 2-bit per entry scheme in the status message. In binary form 00 represents not connected, 01 represents connected but no congestion, and 11 represents connected and congestion exists.

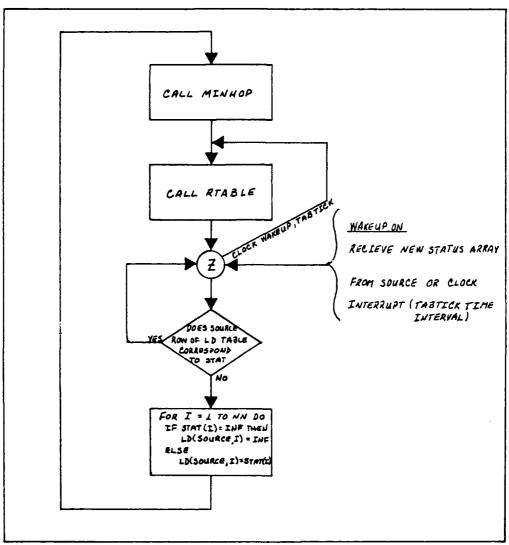


Fig 12. UPDATE

simulation, each entry in the status message uses one word to represent the above with entries of 1000, 1.00, and 1.01 respectively.

RTABLE. RTABLE is shown in Figure 13. The function of RTABLE is to update the source and tandem node routing arrays, SROUTE and ROUTE. Periodically, and after each execution of MINHOP, RTABLE is entered to recompute the routing arrays using the more current D table and local queue lengths.

TTABLE. TTABLE is the module used to build the trunk routing tables. The tables contain the designated trunks over which packets are to be routed, given a selected output link from SROUTE or ROUTE. The implementation of the routing algorithm in the simulation model did not execute TTABLE. Instead, the length of the queues of each trunk in the selected output link is scanned to select the trunk with the shortest queue. That same procedure is used in the execution of TTABLE in any event, only the extra code to actually build and maintain the trunk routing tables TTABLE was not used.

MINHOP. MINHOP calculates the distance table (D table) indexed by outgoing links and final destination node. Table entries encode (conditioned on outgoing links and destination node) the minimum hop count and minimum congestion along minimum hop paths. Entries are pseudo infinite values if the hop count (for outgoing links and destination

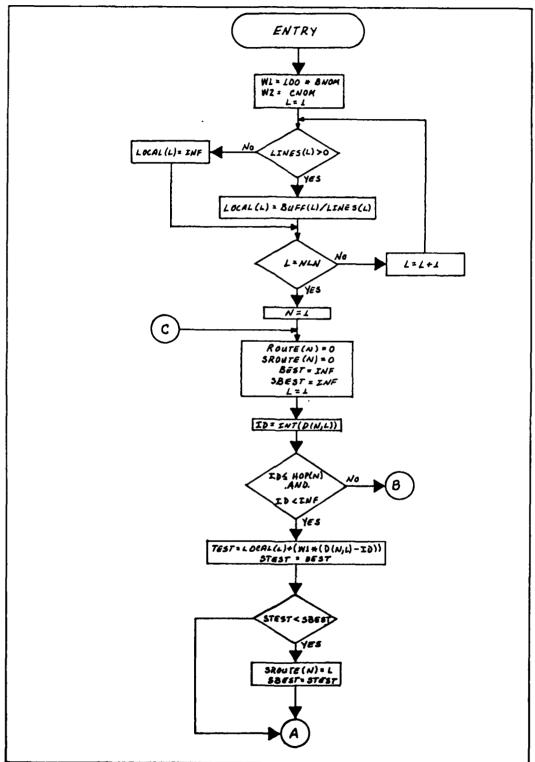


Fig 13. RTABLE

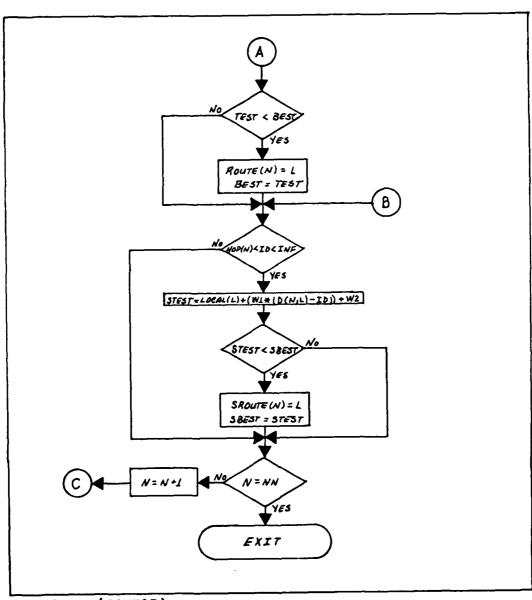


Fig 13. (CONT'D)

node) exceeds the overall (for destination node) minimum hop count plus one (Ref 7:7).

MINHOP is the heart of the routing algorithm. It can be described in four procedures: (1) CONNECTIVITY, (2) INI-TIALIZE_D, (3) COMPUTE_D, and (4) CONN_CHANGE. CONNEC-TIVITY, Figure 14, converts the connectivity information in the link distance (LD) table into more convenient forms of the P and NC arrays. It is entered only once, during initialization. INITIALIZE_D, Figure 15, initializes the D table from the values of the LD table, P and NC arrays. COMPUTE_D, Figure 16, executes a search process to fill out the rest of the D table. The above two procedures are entered if, after a status packet is received, an update to the D table is required. In the interest of clarification, any further references to MINHOP will be synonymous with the execution of INITIALIZE_D and COMPUTE_D. CONN_CHANGE, Figure 17, updates the NC array to reflect link failure or repair. In addition, it updates the LD table which stores the link distance and congestion information (Ref 7:27). CONN_CHANGE is entered when the status of a link changes.

Background Functions

Figure 18 pictorially describes the functions performed by the algorithm in the Background mode. The actuation of a particular procedure is either periodical or event driven. In the Background mode the tasks MINHOP, RTABLE, TTABLE, UPDATE, and MESGEN are executed periodically.

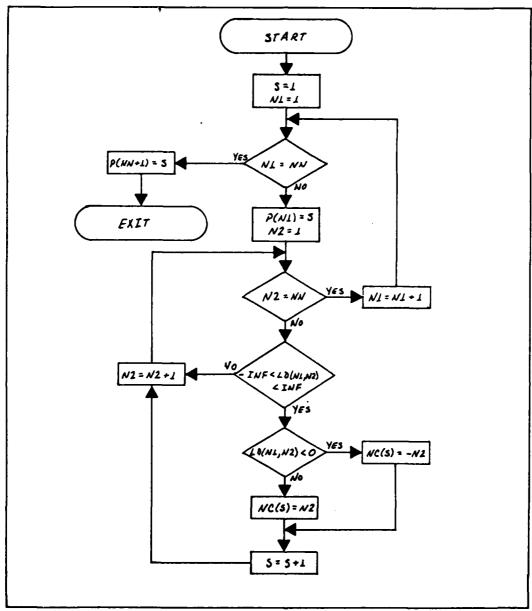


Fig 14. CONNECTIVITY

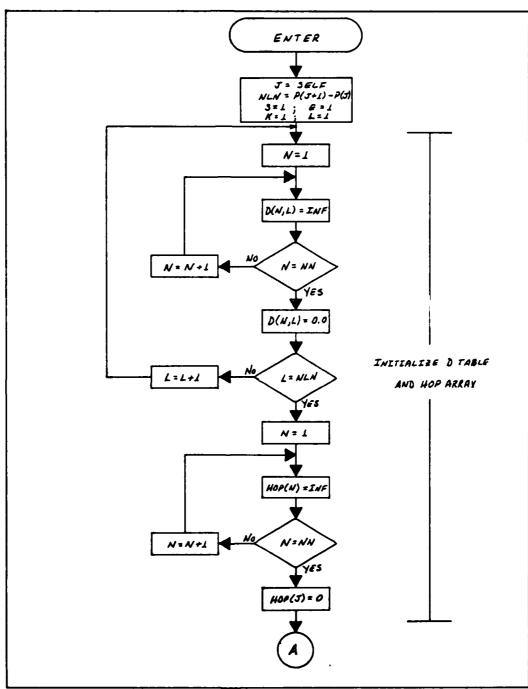


Fig 15. INITIALIZE_D

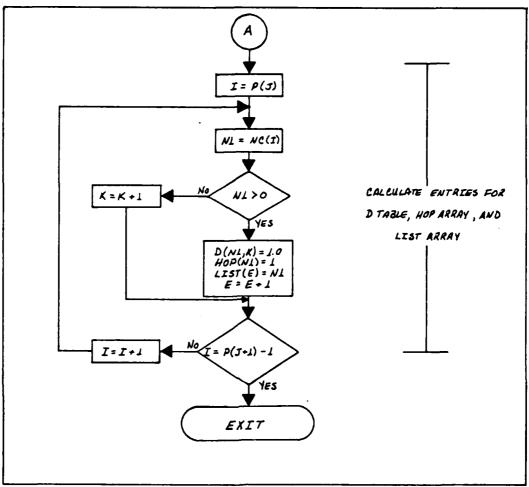


Fig 15. (CONT'D)

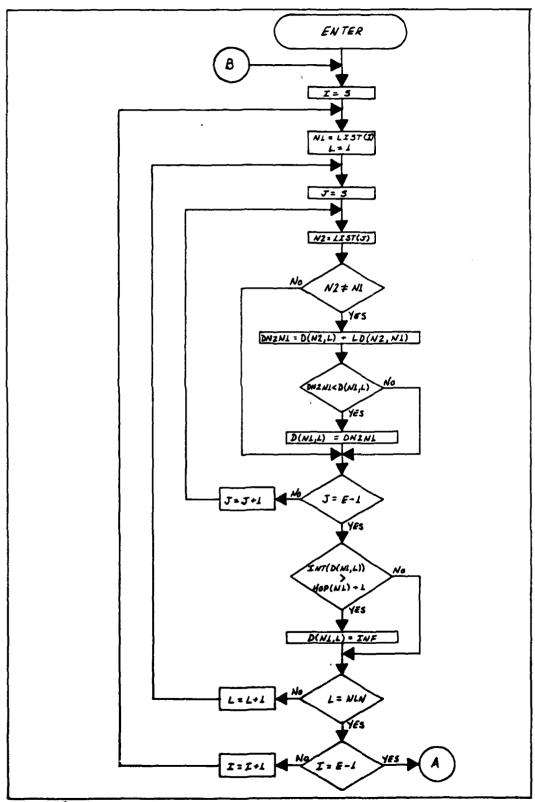
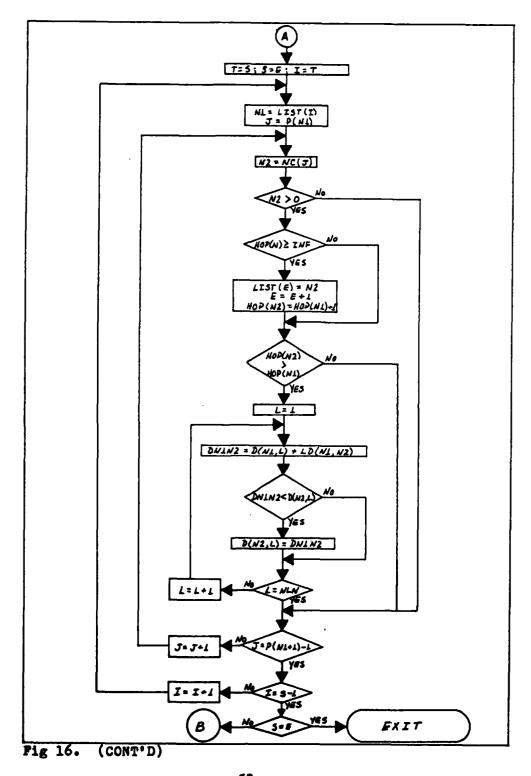


Fig 16. COMPUTE_D



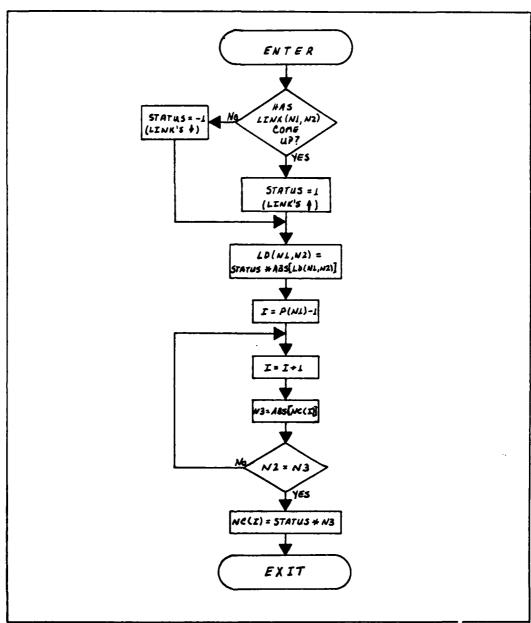


Fig 17. CONN_CHANGE

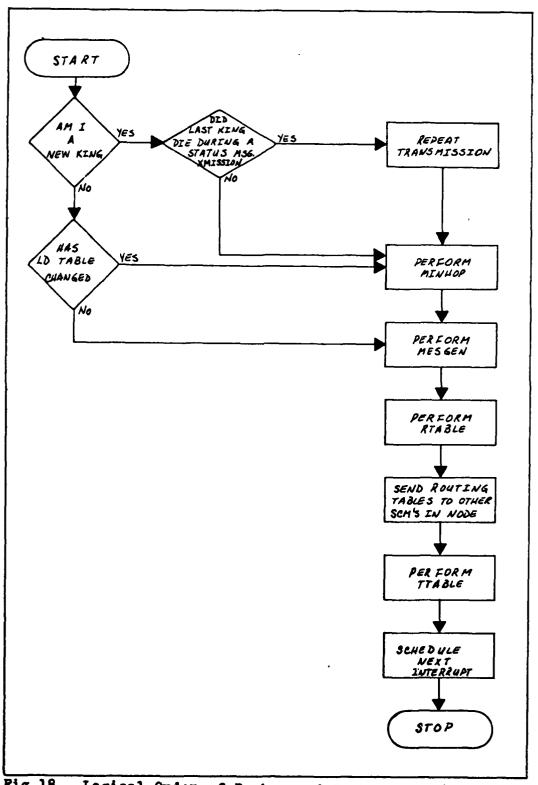


Fig 18. Logical Order of Background Tasks

(Ref 7:19)

If it is time to execute one of the above modules, the processor enters a multi-processing mode where it can process a packet and execute the appropriate module at the same time.

The King determination process was not incorporated into the algorithm as simulated, but will be incorporated into the ON-LINE version of the algorithm. The background tasks of MINHOP, RTABLE, TTABLE, UPDATE and MESGEN need to be done only at one SCM per node. One SCM will thus be designated as the "King", and have responsibility for these tasks (Ref 7:4). The King will be periodically determined in a distributed fashion as the SCM having the minimal load. In the case of a failure of a King processor the next King determination will reestablish order (Ref 7:4). King determination will be interrupt initiated and will be reassigned only upon failure of the current King processor.

To supply the King with the necessary queue information, the SCMs will periodically exchange information vectors containing (Ref 7:4):

- (1) The processor utilization during a specified time interval or other estimates of the current processor load.
- (2) The input queue size for processing at the SCM.
- (3) The output queue sizes for each of the trunks emanating from the SCM having the minimum processor utilization.

Once the King has been established, the queue sizes for trunks are consolidated as queue sizes for links and

the King assumes command of the execution of MINHOP,
RTABLE, UPDATE and MESGEN. The "Coronation Process"
must be executed identically at multiple-SCM nodes in
order for each SCM to arrive at the same SCM to choose as
King. At any time, the King might die (at the very least
hardware errors are very unpredictable), therefore, the
other SCMs at a node must maintain the information necessary
to assume command.

Per Packet Functions

Figure 19 shows a schematic view of the per packet routing tasks. The routing tables produced by RTABLE are used to determine which outgoing link, if any, is to be used. PAKROUTE splits the packets into three broad categories: (1) Packets destined for other nodes, (2) packets destined for the present node, and (3) undeliverable packets (due to hardware failures separating part of the network, etc.) (Ref 4:40). The per packet function mode was not entirely incorporated into the algorithm as exercized in the simulation. The use of the Processor Communications Link (PCL) was not implemented. When a packet enters a node, PAKROUTE is executed by the individual processor processing the packet. As a result of PAKROUTE, the packet is then queued directly to whichever trunk was selected. The functions as portrayed in Figure 19 will be implemented into the ON-LINE version of the algorithm.

As explained in Chapter VII, the hierarchical routing

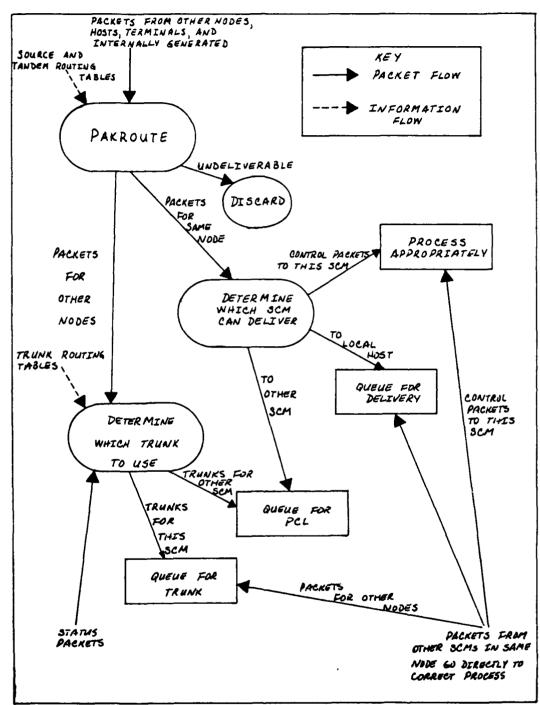


Fig 19. Schematic View of Per Packet Tasks

algorithm was written in the high order programming language FORTRAN IV. The rest of the simulation model was coded in the simulation language, General Purpose Simulation System (GPSS). The following chapter provides a description of GPSS along with a detailed description of the simulation code for one of the nodes in the network.

V GPSS SIMULATION MODEL

Language Description

GPSS (General Purpose Simulation System) was developed in 1961 by Geoffrey Gordon. The primary purpose in developing such a simulation language was to develop a simulation tool for use by systems analysts who were not adept in computer programming. Because of the universality of flow charts, GPSS was structured as a block-oriented language. This idea allows the modeler to construct the model of a system using blocks which are connected together to form a network. The blocks are connected together in the same sequence of events as occur in the system being modeled (Ref 9). A set of unique block types are defined, each corresponding to a basic system action. In this way, system actions and the times at which those actions occur are modeled by drawing a block diagram of the system and inserting the appropriate block instruction to accomplish the desired action. components of the model on which the system acts are called transactions. They in turn, model the dynamic structures of the system. Transactions move through the block structured program, being created, modified, delayed, transferred, or destroyed as required.

Although GPSS was developed to model and simulate a vast scope of various real world physical and abstract systems, it particularly lends itself to the discrete-event simulation of queueing systems. The natural order of en-

tities, instructions, model description and internal organization of the simulator allows a queueing model to be developed, coded, and simulated almost effortlessly.

Transactions, as described earlier, are the principle source of traffic flowing through the model. They represent some operation of the system being simulated but the modeler defines what those operations are. Transactions move from block to block in a manner similar to units of traffic in the real system they represent. Each movement is considered to be an event that is due to occur at some point in time. GPSS automatically maintains a sequential record of the events which are to occur. In those cases when events (such as attempting to seize a facility which is already in use) cannot take place at the instant in time when they were originally scheduled, the transaction ceases to move until the event can take place. During a transaction's scheduled movement, it moves through as many blocks as it can before being denied entry to a block. The program maintains the status of the condition causing the transaction to be delayed. As soon as the condition changes, the transaction proceeds in the appropriate sequence with respect to the other transactions, that is, the transactions scheduled to move first do so. Associated with each transaction are attributes called parameters. These parameters enable the modeler to keep track of, collect, and modify dynamically those characteristics which are of particular interest to the modeler about that particular transaction.

The GPSS model is made up of blocks correlating to the block diagram constructed to define the modeled system. Each block can be thought of as a small subroutine or macro instruction. Each block is associated with information falling into three categories; location, operation, and operands (Ref 10). Every block occupies a specific location in the block diagram. The first block in a model occupies location 1, the second block occupies location 2, and so on. The GPSS Processor automatically assigns a location number to each block unless the user option is utilized in which the modeler labels a particular block with a name of his own choice containing from three to five alphanumeric characters, the first three of which must be alpha. The block's number, or label, can be referenced in later blocks. The "operation" of a block is a "verb" suggestive of the task the block accomplishes. Each block type is characterized by its own predefined verb, that is, GENERATE, ASSIGN, QUEUE, SEIZE, and TRANS-FER just to name a few. A block has operands whose values identify the specific actions the block is to take. operands can be conveniently thought of as arguments used in subroutine calls. Four basic types of events occur with a block: (1) creation or destruction of a transaction,

- (2) alteration of a numerical attribute of a transaction,
- (3) delay of a transaction for some specified amount of time, and (4) alteration of the transaction flow through the model.

There are four categories of block types. They are transaction-oriented, transaction flow-modifying, equipment-oriented, and statistical. Transaction-oriented blocks deal with the transaction itself. A transaction can be created as in the GENERATE block, destroyed as in the TERMINATE block, delayed as in the ADVANCE block, have its parameters modified as in the ASSIGN block, or have its priority changed as in the PRIORITY block. Flow-modifying blocks modify the flow of transactions through the model. The TRANSFER block is generally used to direct a transaction to a nonsequential next block. The LOOP block causes the transaction to loop through a specified set of blocks until a condition is met or satisfied. block allows transfer of a transaction upon testing a specified condition which is the result of an algebraic comparison between two operands of the block. Equipmentoriented blocks define how a transaction controls the simulated device, facility, equipment, process or other entity the transaction is currently using. The SEIZE block indicates the use of a facility by the entering transaction so that the facility remains in use until the seizing transaction releases the facility by entering a RELEASE block. When a transaction with high priority enters a PREEMPT block, it suspends the progress of the lower priority transaction which had previously seized the facility. The higher priority transaction gains control of the facility and when it is through with the facility, returns control back to the preempted transaction by entering a RETURN block. If some type of storage entity is being modeled, a transaction entering an ENTER block obtains a specified number of units of the storage entity. When the used storage is to be returned, the transaction enters a LEAVE block. Statistical block types cause specified statistics to be gathered and stored pertaining to the desired program entity. When a transaction enters a QUEUE block, queue statistics on that transaction such as the number of transactions currently in the queue, maximum number of transactions in the queue at any one time, average time for a transaction to spend in the queue, and the number of transactions that incurred no wait time spent in the queue are activated. The DEPART block removes the transaction from the queue and causes the actual statistics discussed above to be gathered and stored for later output at the end of the simulation. The blocks discussed above are by no means all the blocks available but do lay the fundamental groundwork needed to understand the simulation model to be discussed shortly.

Output from the simulation includes statistics on the queues, facilities, storages, specifically defined program entities called SAVEVALUES, and any tabular data generated by transactions entering a TABULATE block.

The following section describes the basic program used to simulate the AUTODIN II simulation model.

Program Description

Two versions of the simulation program were used. Chapter VI explains the specific details for the Baseline or control program using fixed routing. Chapter VII explains the incorporation of the hierarchical routing algorithm into the simulation model.

The simulation program models the eight node AUTODIN II communication computer network. The eight nodes are Albany, Andrews, Ft. Detrick, Gentile, Hancock, McClellan, Norton, and Tinker. Figure 20 shows how the nodes are connected together, the number of SCMs at each node, and how the trunks are connected to the SCMs at the nodes. In general, the processing and routing of packets at each node is the same. The simulation program must generate packets (simulating packets received from locally connected Host computers and terminals), assign the appropriate priority, length, source and destination node identification number to each packet, and queue and transmit the packet to the appropriate node (which will either be the destination node or an intermediate tandem node). Figure 21 is typical of the program block diagram for each node. The number of SCM processors, queues, and trunks a node has is peculiar to each node. example, the block diagram is shown for the Andrews node in the Baseline simulation model. The packets are generated with some mean interarrival rate peculiar to each node and are exponentially distributed. In Figure 21, the GENERATE

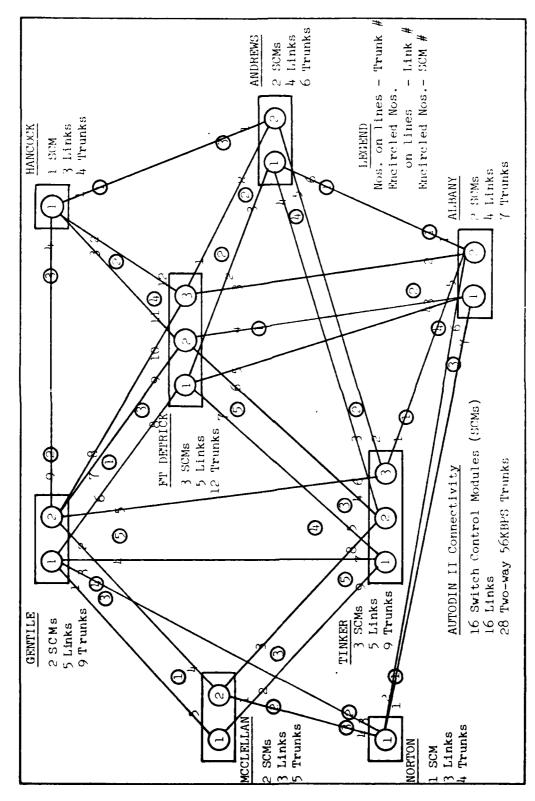


Fig 20. Network Layout of AUTODIN II

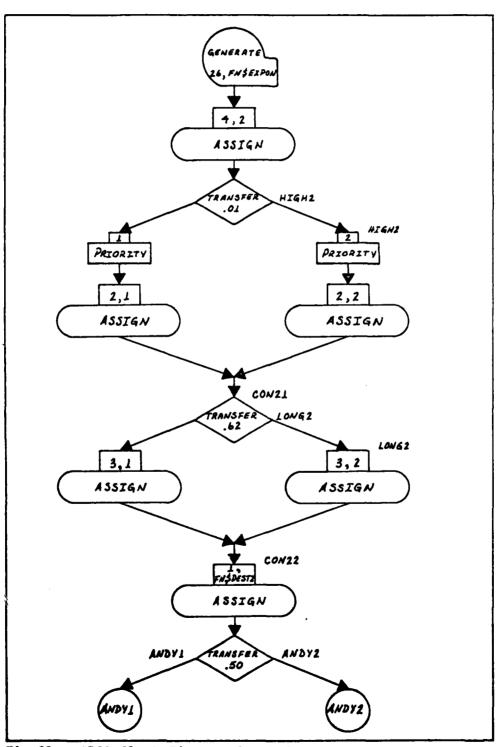


Fig 21. GPSS Block Diagram for Andrews

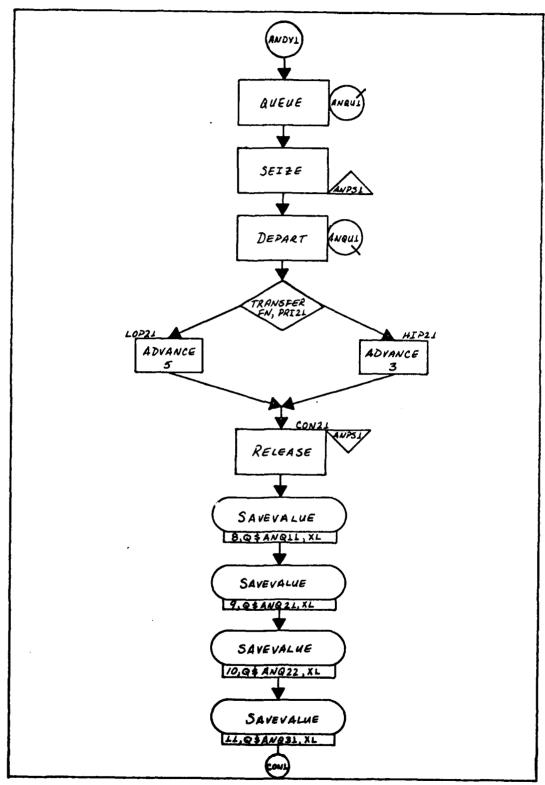


Fig 21. (CONT'D)

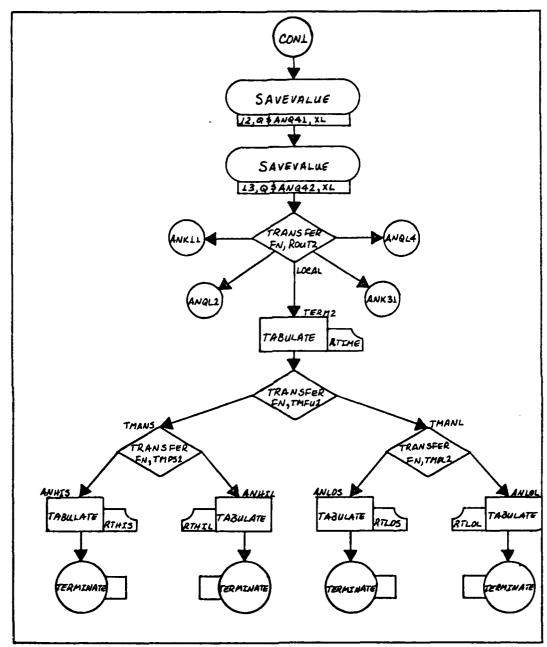


Fig 21. (CONT'D)

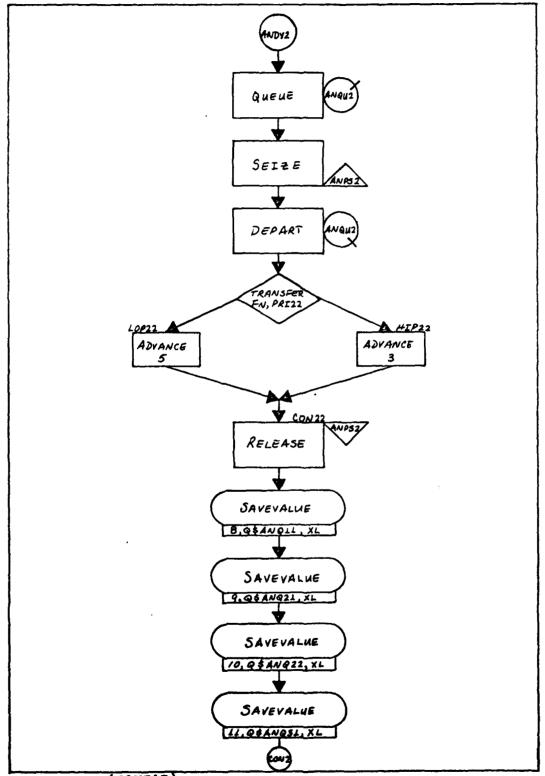


Fig 21. (CONT'D)

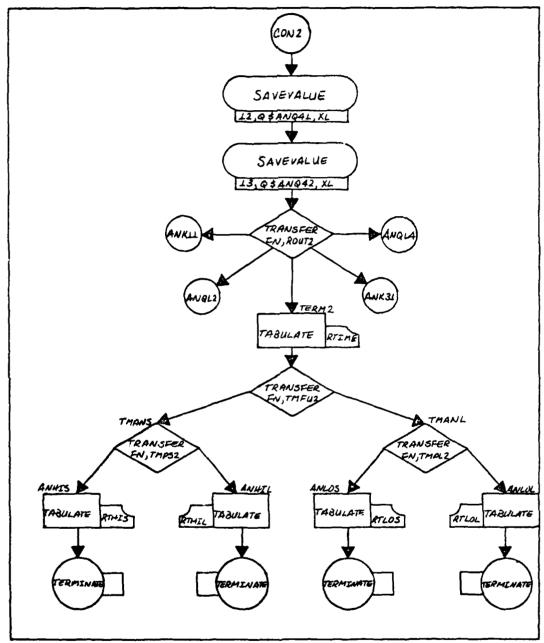


Fig 21. (CONT D)

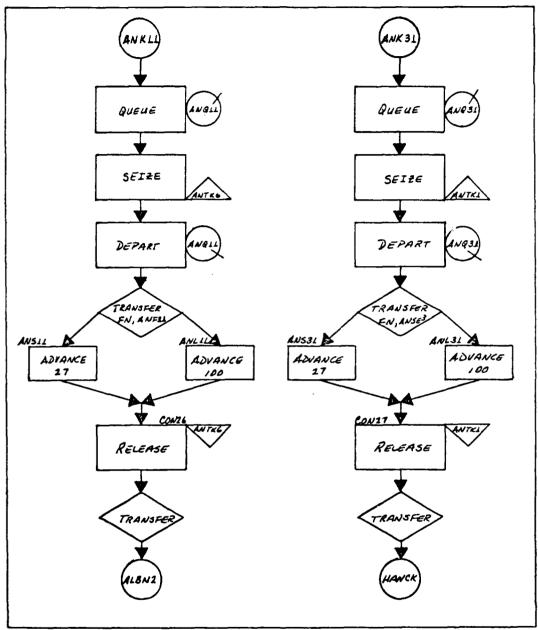
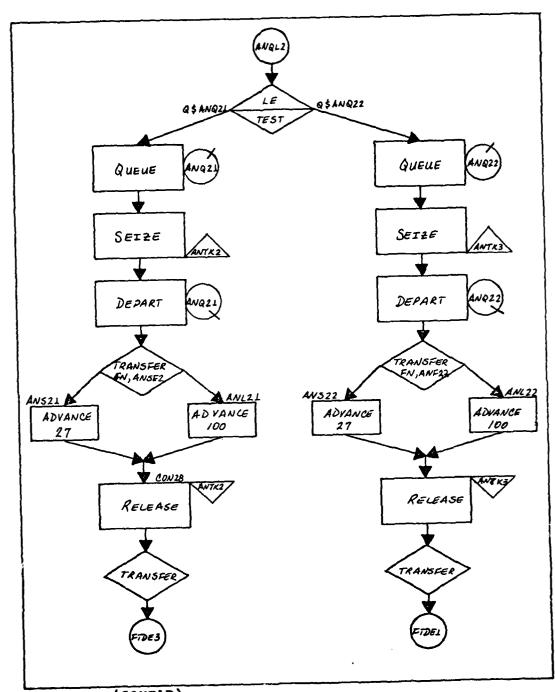


Fig 21. (CONT'D)



Pig 21. (CONT'D)

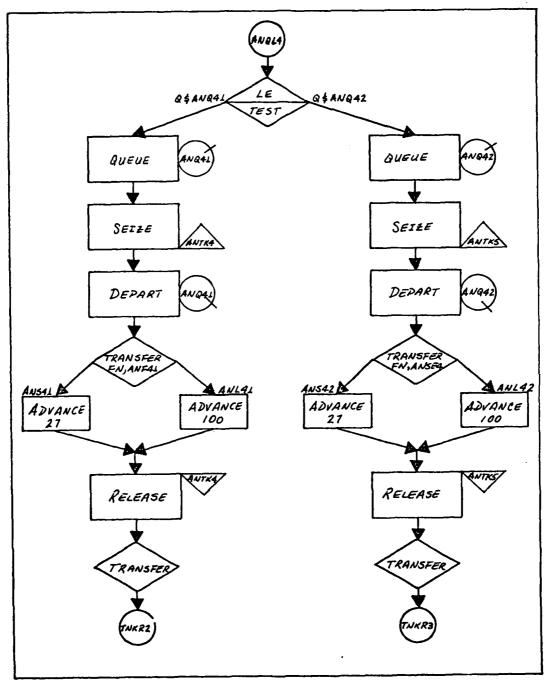


Fig 21. (CONT'D)

block uses the FUNCTION EXPON to determine the exponential distribution of the packets. Random number generator 1, RNI, is used to generate a random number from .00000 to 1.00000. This random number is then used to select which multiplication factor (from the FUNCTION EXPON) to multiply against the given mean interarrival rate (1st operand of GENERATE block) of the packet. The result of the multiplication becomes the number of time units (in this case milliseconds) which must pass before the next packet is generated. The packet priority, packet length, and source node identification number are assigned to the packet's second, third, and fourth parameter values respectively by the ensuing ASSIGN blocks. The packet's destination node identification (ID) number is generated using FUNCTION DEST2. Random number generator two, RN2, is used to generate a random number from .00000 to 1.00000. That number is used to select a number from 1 to 8 which becomes the destination node ID number. It is stored in parameter 1 of the packet.

The packet is transferred to either SCM 1 (ANDY1) or SCM 2 (ANDY2) where it is queued for input processing. For ease of explanation, SCM 1 is assumed to process the packet. When the processor is available, the queued packet seizes it and the packet departs the queue. FUNCTION PRI21 uses the value in parameter 2 of the packet (1 for non-priority and 2 for priority) to determine how much processing time the packet acquires (5 milliseconds for non-priority and 3 milliseconds for priority packets). The packet releases

the processor and moves into the SAVEVALUE blocks. In this simulation program, the SAVEVALUE blocks are used to store the lengths of the output trunk queues. The SAVEVALUEs are used later on in the program to assist in determining which trunk to route the packets over. SAVEVALUES 8 through 13 are used for saving the queue lengths at the Andrews node. Everytime a packet is input processed (accomplished by the packet executing this sequence of blocks), new current values of the output queue lengths are stored in the SAVE-VALUES. When the packet enters the following TRANSFER block, packet parameter 1 (destination node's ID number) is used in FUNCTION ROUT2 to select the link over which to route the packet. In the case parameter 1's value is a 2, the packet is delivered locally. When a packet terminates locally, the delay time the packet has acquired from time of generation to its delivery at its destination is tabulated (by the TABULATE block) in the system delay table RTIME. Depending on its priority and length, the packet's delay time is further tabulated in either the RTHIS table (priority - short), RTHIL table (priority - long), RTLOS table (nonpriority - short) or the RTLOL table (non-priority - long). The packet then enters a TERMINATE block where it is removed from the system. For the example that a packet is to be routed to another node, suppose the packet's destination is Tinker (ID = 8). The packet enters the TEST block labeled ANQL4. Since the Tinker link contains two trunks, the decision has to be made which trunk to select. The TEST block

compares the two queue lengths (ANQ41 and ANQ42) and the packet enters either the queue ANQ41 or the queue ANQ42. Again for ease of explanation, assume the packet enters the queue ANQ42. The selected trunk, ANTK5, is seized when available and the packet departs ANQ42. Based on the packet length value in parameter 3 (1 - short, 2 - long), and the FUNCTION ANSE4, the packet acquires either 27 milliseconds if a short packet or 100 milliseconds if a long packet when it enters the appropriate ADVANCE block. Having acquired the correct transmission time, the packet releases the trunk and transfers to Tinker's SCM 3 where it is further processed and delivered.

The following chapter explains the specifics on how the mean interarrival rates are determined, where the values for processing and transmission come from, source node packet routing matrices, and how the simualtion is run for the Baseline model.

VI <u>Initial Baseline Considerations</u>

In order to have something to compare the algorithm version of the simulation model against, a baseline or control program was developed. The basic processes of packet generation, assigning lengths, priorities and destination node IDs to packet parameters are the same in both programs. Packet input and output processing is the same in both programs as is the termination of packets. The only difference in the two programs is the methodology used in selecting trunks and links over which to route the packets.

The baseline model uses static or fixed routing, that is, given a packet currently at node i destined for node j, a predetermined link k is always used. This route is derived from a given network routing matrix to be explained shortly. The algorithm model, of course, uses the hierarchical routing algorithm to determine the best link and therefore the best trunk over which to route the packet. The next chapter explains the incorporation of the routing algorithm into the simulation model.

This chapter explains how the packet generation rate is calculated for each node. Since each node does not have the same number of Host computers and terminals connected to it, the number of packets entering the node (from the Host computer and terminals) per unit of time is different for each node. The procedure used to calculate the packet mean interarrival rate (time between arrivals

of packets to the node) is explained in detail. The assignment of a destination to a packet is based on the fact that a certain percentage of the packets originating at a node goes to each of the other nodes including the originating, or source node. These percentages and how they are calculated for each node are discussed along with how the percentages are implemented in the baseline program. The ideas of different packet priorities and accumulation of delay time are also discussed in this chapter. The Network Routing Matrix (Ref 17:11), is used to determine which node processes the packet next, given the source node and destination node of the packet. The part it plays in the simulation model is also explained in this chapter. The last section of this chapter explicitly explains how the simulation model was run and gives some sample results of the baseline simulation model.

Packet Interarrival Times and Length Determinations

The calculation for the packet interarrival times is a complex process. It involves the use of predetermined statistical data (Ref 17:V-B-110), assumptions made by Systems Control Incorporated (SCI) during their development and partial simulation of the hierarchical routing algorithm (Ref 18:1-2), and a limited number of educated assumptions on the author's part. The author's assumptions were confirmed by telephone conversations with DCA representatives through the Defense Communications Engineering Center (DCEC), Reston, Virginia. When used, each of the assumptions referenced

above is explained.

When a packet is generated, among other parameters, it is assigned one of two lengths. A long packet is 4704 bits in length and a short packet is 600 bits in length. The percentage factors of how many long and short packets are generated are the other results of the packet interarrival time calculations.

In their development and partial simulation of the algorithm, SCI calculated that 81.3% (Ref 18:2), of all the bits in the network are data packet bits. The maximum throughput, or trunking capacity (maximum number of bits able to be supported by the total number of trunks in the network) of the AUTODIN II network is simply the number of trunks multiplied by the transmission speed of the trunks. By the calculation 28 x 2 x 56KBPS (the 2 is because each trunk is two-way), the trunking capacity is 3.136 million bits per second (MBPS). The number of data bits in the network then becomes 81.3% of 3.136 MBPS or 2,549,568 data packet bits. A determination has to be made as to how those bits enter the network, that is, how many of those bits enter the network from Albany, Andrews, and the rest of the nodes.

There are two types of subscribers (users) that connect to nodes and send data into the network. They are Host and terminal subscribers. Host subscribers are large information or computational sources (referred to also as host systems or host computers) (Ref 17:V-1-55). Terminal subscribers, which include terminal computers, are generally mini- to

small-size computers that serve as communications handlers or terminal concentrators and may also provide some limited local computational capacity (Ref 17:V-1-55). They also include input-output devices such as teletypewriters (TTYs), cathode ray tube (CRT) terminals, printers, remote batch terminals, card and magnetic tape terminals (Ref 17:V-1-56). Terminal users input data that is formatted into a combination of long data packets (4704 bits) and short data packets (600 bits) (Ref 18:1). Host users input data that is formatted into long data packets only (Ref 18:1). The percentage of short packets generated from terminal users is 81.25% and the percentage of long packets generated is 18.75% (Ref 18:1).

The actual statistics to which the above percentages apply is in the form of information provided by DCA (Ref 17:V-B-110) as shown in Table II. Since the adjusted trunk capacity figure of 2,549,568 bits is for data packets (including a network overhead of 528 bits of network information), the size of a long data packet is 4704 + 528 bits, or 5232 bits. The size of a short data packet thus becomes 600 + 528 or 1128 bits. These two numbers are used as shown in Table III, in order to calculate normalized figures.

Normalization is necessary because the total number of bits input from Host and terminal subscribers is slightly less than the adjusted trunk capacity of the network. An assumption on the part of the author is that the figures shown in Table III represent the maximum number of bits input into the

TABLE II

Subscriber Input by Node

(Derived from projected Busy Hour Statictics)

Switch	=	Hosts		Terminals		
	Send Traffic (BPS)	Equivalent # of long packets	Send Traffic (BPS)	Send Equivalent # Traffic of long (BPS) packets	Equivalent # of short packets	Total # of packets input per second
Albany	168965	35.919	16991	.665	22.607	161.65
Andrews	434927	92.459	61750	2.461	83.623	178.543
Pt. Detrick	k 50310	10.695	2667	901.	3.612	14.413
Gentile	210813	918-44	33285	1.327	45.075	91.218
Hancock	157127	33.403	10564	.421	14.306	48.130
McClellan	147544	31.366	20861	.831	28.250	244.09
Norton	179069	38.067	1906	.361	12.270	869.05
Tinker	498389	105.950	78467	1.175	39.928	147.053
	1847144	392.675	184366	7.347	249.671	649.693

Total number of bits in network as a result of maximum subscriber input (plus overhead =

392.675 x 5232 = 2054475.6 bits (Hosts)

 $7.347 \times 5232 = 38439.5$ bits (Terminals, long packets) $249.671 \times 1128 = 281 628.9$ bits (Terminals, short packets)

2374544.0 bits Total input

TABLE III

Normalized Subscriber Input

Number of Data Packet Bits in Network in any given/second Busy Hour period = (from trunk capacity figure)

3136000 BPS x .813 x 1 second = 2549568 bits

Normalization factor $\frac{2549568}{2374544} = 1.0737$

This factor is now multiplied against each of the Host and terminal subscriber inputs to determine the normalized input packet rate at each node.

Switch	Hosts	ø,		Terminals	αį	
	Send Traffic (BPS)	Equivalent # of long packets	Send Traffic (BPS)	Equivalent # of long packets	Equivalent # of short packets	Total # of packets input per second
Albany	181417	38.566	17924	.714	24.274	63.554
Andrews	186991	99.273	96300	2.642	89.785	191.700
Ft. Detrick	54018	11.483	2863	.114	3.877	15.474
Gentile	226350	48.118	35738	1.424	48.397	97.939
Hancock	168707	35.864	11342	.452	15.360	51.676
Mcclellan	158417	33.677	22398	.893	30.332	64.902
Norton	192266	40.872	9728	• 388	13.175	54.435
Tinker	535120 1983276	113.758	31656	1.262	42.870	157.890 697.570

TABLE III (CONT'D)

Total number of bits in network as a result of maximum subscriber input (plus overhead) =

421.61 x 5232 = 2205863.5 bits (Hosts)

7.89 x 5232 = 41280.5 bits (Terminal, long packets) 268.07 x 1128 = 302383.0 bits (Terminal, short packets)

which is .0016% under the adjusted trunk capacity of 2549568 bits (difference is 2549527.0 bits

697.57

due to round-off errors made during the

calculations)

Percent of long packets = $\frac{429.50}{697.57}$ = 62%

Percent of short packets = $\frac{268.07}{697.57} = 38\%$

network if the Host and terminal subscribers (currently scheduled to be part of the AUTODIN II network) input data at their respective maximum rates. Theoretically, if this were to occur, the entire network would be in a state of saturation. The Host and terminal subscribers input 81.3% of the trunking capacity of 3.136 MBPS and the nodes themselves add the additional 18.7% due to required network control and synchronization information. The last thing shown in Table III is the determination of the percentages of long and short packets (62% of all packets input are long and 38% are short packets).

Table IV shows the input packet rate per node at the maximum subscriber input rate. Under normal operating conditions, the subscribers would input at about 20% of the rate shown. Thus, the network would nominally operate at 20% trunk loading as confirmed from DCA by telephone conversation. Table IV shows what the input rates, in packets per second (PPS), into the nodes would have to be in order to produce trunk loading of 100% (saturation), 90%, 80%, 70%, 60%, 50%, 40%, and 20% (normal operating traffic level). Also shown in Table IV are the packet interarrival times (inverse of the input packet rate) in milliseconds per packet (MSPP). These constitute the mean packet interarrival times used to generate packets in the simulation model using the GENERATE blocks. Appendix A is the portion of the baseline simulation program representing the code necessary for the Andrews node. The code closely resembles the Block Diagram

TABLE IV

Packet Input Rates and Interarrival Times

				,		1	1		
USA TAG		,	Š	71.	saturat	Saturation Levels	818	-	,
		100%	%06	808	80% 70%	809	50 8	\$0 \$	20%
Albany									
Input Rate (PPS)		63.55	57.19	50.84	84.44	38.13	31.77	25.42	12.71
Interarrival Times (MSPP) 16	(MSPP)	16	17	20 22 26 31	22	56	31		62
Andrews									
Input Rate (PPS) 191.70 172.53 153.36 133.19 155.02 95.85	•	191.70	172.53	153.36	133.19	155.02	95.85	96.68	38.34
Interarrival Times	(MSPP)	ν,	9	2	89	6	10	13	56
Ft. Detrick									
Input Rate (PPS) 15.47 13.92 12.37 10.42 9.28 7.73 6.19 3.09		15.47	13.92	12.37	10.42	9.28	7.73	6.19	3.09
Interarrival Times	(MSPP)	65	72	81	96	108	129	191	323
Gentile									
Input Rate (PPS) 97.94		46.76	88.14	78.35	68.55	58.76	48.97	39.17	19.50
Interarrival Times	(MSPP)	10	11	11 13 15 17 20 26 51	15	17	20	56	51
Hancock									
Input Rate (PPS) 51.67 46.50 41.33 36.17 31.00		51.67	46.50	41.33	36.17	31.00	25.83	20.67	10.33
Interarrival Times	(MSPP)	19	22	77	28	32	39	39 448	26
McClellan									
Input Rate (PPS)		06.49	58.41	51.92	45.43	38.94	32.45	25.96	12.98
Interarrival Times (MSPP) 15 17 19 22 26 31 39 78	(MSPP)	15	17	19	22	56	31	39	98

AD-A080 484 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOO--ETC F/G 17/2 AN ANALYSIS OF A ROUTING ALGORITHM FOR AUTODIN II.(U) DEC 79 JA WHITTENTON AFIT/OCS/EZ/79-18 NL UNCLASSIFIED NL 2..5

TABLE IV (CONT'D)

Packet Input Rates and Interarrival Times

Switch			Š	Saturation Levels	n Level	e ni		
	100%	806	80%	80% 70% 60%	80%	50%	40%	20%
Norton								
Input Rate (PPS)	54.44	48.99	43.55	54.44 48.99 43.55 38.11 32.66 27.22 21.77	32.66	27.22	21.77	10.89
Interarrival Times (MSPP) 18	18	20	23	56	31	37	94	92
Tinker								
Input Rate (PPS)	157.89	142.10	126.31	157.89 142.10 126.31 110.52 94.73 78.94 63.15 31.58	94.73	78.94	63.15	31.58
Interarrival Times (MSPP) 6	9	2	œ	6	11	13	16	32

code in Figure 21, Chapter V. The encircled "A" shows the GENERATE block instruction with the corresponding packet mean interarrival time of 26 milliseconds exponentially distributed by the FUNCTION EXPON. Further explanation of the use of the different packet interarrival times is forthcoming in a later section of this chapter.

Priority Length and Destination Assignments

In order for a packet to receive preferential treatment (be processed or transmitted before other packets even though it entered a queue after the other packets) it is flagged or assigned a priority level higher than those of the other packets. In the simulation model a packet is either a priority or a non-priority packet. A priority packet does not preempt or interrupt a non-priority packet that is being processed by an SCM or transmitted on a trunk. Priority packets do move to the head of the queue by passing non-priority packets. Ninety nine percent of the input packets are non-priority, and one percent is given the priority assignment (Ref 18:3). This process is accomplished at the encircled "B" in Appendix A. The TRANSFER instruction sends 1% of the packets to the instruction labeled HIGH2 where they are given the priority status of 2 (stored in parameter 2 of the packet). The other 99% of the packets are given the non-priority status of 1 (stored in parameter 2 of the packet). The values in parameter 2 are used later on to determine the amount of processing time a packet requires.

as determined in Table III, 62% of the packets generated are long packets and 38% are short packets. The simulation model accomplishes this task at the encircled "C" in Appendix A. The TRANSFER instruction labeled CON21 sends 62% of the packets to label LONG2 where parameter 3 of those packets are given the value of 2 denoting a long packet. The other 38% of the packets fall through TRANSFER instruction and are given the value of 1 in parameter 3 denoting a short packet. The values assigned to parameter 3 of each packet are used later on to determine the amount of transmission time each packet requires.

In determining which node is to be the destination of a packet, the information (Ref 17:V-B-131) in Table V is used. It represents node-to-node data packets exchanged for a given time unit. Each row represents the number of packets terminating locally (source node and destination node the same) and the number of packets the source node sends to all the other nodes. From this information Table VI is derived. Instead of the number of packets sent to each of the other nodes, entries in Table VI represent the ratios of packets transmitted to each of the other nodes from a source node. The ratios are calculated, using Table V, by summing up each row to obtain the total number of packets sent by a source node. Each column entry, given the source node, is divided by the appropriate row total to calculate the ratio of packets sent to a particular destination node. At the encircled "D" in Appendix A, parameter 1 of a packet is

TABLE V

Node-to-Node Packet Exchange

TO	ALBANY	ANDREWS F1	. DETRICK	GENTILE	HANCOCK	ANDREWS FT. DETRICK GENTILE HANCOCK MCCLELLAN NORTON TINKER	NORTON	TINKER	ROW
FROM:									TOTAL
ALBANY	15.88	24.70	1.72	8.22	7.21	4.76	10.12	10.12 38.70 111.31	111,31
ANDREWS	35.66	127.11	12.81	20.80	35.28	17.20	17.14	31.86	297.76
FT. DETRICK	1.55	13.53	0.32	2,58	2.07	84.4	0.12	7.10	31.75
GENTILE	13.68	26.31	3.07	43.33	8.63	16.72	10.79	10.79 23.81	146.34
HANCOCK	6.41	38.53	3.28	2.05	17.78	5.89	5.80	5.80 15.79	100.53
MCCLELLAN	6.56	14.00	4.25	00.9	5.28	33.67	9.19	9.19 22.01	100.96
NORTON	16.70	28.22	0.13	7.87	12.55	18.41	13.80	13.80 15.11	112.79
TINKER	43.49	41.61	6.92	44.79	27.07	43.15	21.42	88.02	316.47

TABLE VI

Node-to-Node Packet Exchange Ratios

					0				
TO	ALBANY	ANDREWS	FT. DE	DETRICK	GENTILE	GENTILE HANCOCK	MCCLELLAN	NORTON	TINKER
PROM:									
ALBANY	.1427	.2219	0	.0155	.0738	8490.	.0428	6060•	.3476
ANDREWS	1194	•4269	70.	0640	6690*	.1185	•0578	.0575	.1070
FT. DETRICK	• 0488	.4261	0	.0101	.0813	.0652	1411	.0038	.2236
GENTILE	.0935	.1798	0.	.0210	.2961	.0590	.1143	.0737	.1626
HANCOCK	•0638	.3833	0	.0326	.0701	.1769	• 0586	.0577	.1570
MCCLELLAN	.0650	.1387	40.	1240	•0594	.0523	.3335	0160.	.2180
NORTON	.1481	.2502	00.	2100	2690.	.1113	.1631	.1224	.1340
TINKER	.1374	.1315	• 05	.0219	.1415	.0856	.1363	.0677	.2781

assigned a destination node ID number using the FUNCTION DEST2. The function, encircled "E" in Appendix A, uses random number generator two, RN2, to generate a random number from .00000 to 1.00000. The next line following DEST2 contains eight discrete intervals, each interval separated by a slash. The decimal numbers in the intervals are the cumulative sums of Andrew's row in Table VI. difference between the nth and nth + 1 intervals are the ratio entries in Andrew's row of Table VI. For example, the difference between the 4th and 5th entries is .7777 -.6592, or .1185. Looking at Table VI, this number corresponds to the ratio of packets originating at Andrews with Hancock as the destination node. After the .7777 entry is the number 5, which is Hancock's node ID number. If the generated random number is between .6592 and .7777, then parameter 1 of the packet currently being processed is assigned the integer number 5, denoting the destination node of the packet to be Hancock. The rest of the intervals in DEST2 are derived in the same fashion, that is, for random number values in the range .00000 to .11940, the packet is assigned destination node ID of 1 (Albany), .11941 to .54630 (.1194 + .4269) the ID is 2 (Andrews), .54631 to .5893 (.5463 + .0430) the ID is 3 (Ft. Detrick), and so on.

All of the pertinent packet parameter values have now been assigned to the packet. Parameter 1 contains the destination ID number (1 to 8), parameter 2 contains the priority status (1 - non-priority, 2 - priority), parameter 3 con-

tains the packet length (1 - short, 2 - long), and parameter 4 contains the number 2 which indicates Andrews as the packet's source node. The packet is now ready to enter one of the two SCMs to be processed and transmitted on to the next node (which might be its destination node or a tandem node). This is accomplished by the TRANSFER instruction (encircled "F" in Appendix A).

Packet Processing and Transmission

Not only do new packets just generated enter either ANDYl or ANDY2, but also the packets sent to the Andrews node from other nodes enter Andrews at these two entry points. For ease of explanation, assume the packet is sent to SCM 1. order to receive service, the packet enters the processor's input queue, seizes the processor when it is available, and departs the processor's input queue as shown in Appendix A, encircled "G". If the packet is a priority packet, it moves to the front of the FIRST-IN-FIRST-OUT (FIFO) input queue ANQUI. If the processor ANPS1 is busy (currently seized by another packet), the queued packet remains in the queue until the processor is free. When the packet seizes the processor it acquires a certain amount of processing delay time depending on its priority (encircled "H", Appendix A). To determine the priority of a packet, FUNCTION PRI21 (encircled "I") is used by the TRANSFER instruction. Packet parameter 2 is inspected and if it is a 1 (non-priority), the packet is transferred to the label LOP21 where the ADVANCE instruction

adds 5 milliseconds (Ref 17:V-B-26) to the packet's system time parameter (located in GPSS's system tables). If the packet parameter is a 2 (priority), the packet transfers to the label HIP21 where the ADVANCE instruction adds 3 milliseconds (Ref 17:V-B-26) to the packet's system time parameter. After receiving the appropriate amount of SCM processing time, the processor is released (encircled "J", Appendix A).

The packet now enters the SAVEVALUE instructions (encircled "K", Appendix A). ANQ11 through ANQ42 are the output queues associated with the output trunks emanating from the Andrews node. The lengths of the queues, or number of packets in each queue, are stored in SAVEVALUES 8 through 13. All the necessary conditions for the packet to start the transmission process have now been accomplished.

When the packet enters the TRANSFER instruction located at the encircled "L", Appendix A, the FUNCTION ROUT2 (encircled "M", Appendix A) uses the value in packet parameter 1 to determine which outgoing link on which to queue the packet. When the destination node of a packet is not a directly connected node to the node processing the packet, a tandem or intermediate node is selected. Due to the 2-hop constraint, if a node is a tandem node it is directly connected to the destination node. Table VII (Ref 18:11) is used in the next-node determination. Given the source node (row headings), and the destination node (column headings), the entries give the next node to process the packet (inc-

TABLE VII Network Base Routing Matrix

TO: FROM:	ALBANY	ANDREWS	PT DETRICK	GENTILE	HANCOCK	HANCOCK MCCLELLAN	NORTON	TINKER
ALBANY	ALBANY	ANDREWS	FT DETRICK	FT DETRICK	DETRICK ANDREWS	NORTON	NORTON	TINKER
ANDREWS	ALBANY	ANDREWS	FT DETRICK	FT DETRICK	DETRICK HANCOCK	TINKER	ALBANY	TINKER
PT DETRICK	ALBANY	ANDREWS	FT DETRICK	GENTILE	HANCOCK	GENTILE	ALBANY	TINKER
GENTILE	FT DETRICK	PT DETRICK FT	FT DETRICK	GENTILE	HANCOCK	HANCOCK MCCLELLAN	NORTON	TINKER
HANCOCK	ANDREWS	ANDREWS	FT DETRICK	GENTILE	HANCOCK	GENTILE	GENTILE	ANDREWS
MCCLELLAN	NORTON	TINKER	GENTILE	GENTILE	GENTILE	GENTILE MCCLELLAN	NORTON	TINKER
NORTON	ALBANY	ALBANY	ALBANY	GENTILE	GENTILE	GENTILE MCCLELLAN	NORTON	GENTILE
TINKER	ALBANY	ANDREWS	FT DETRICK	GENTILE	ANDREWS	ANDREWS MCCLELLAN GENTILE	GENTILE	TINKER

luding tandem and destination nodes). The values of the FUNCTION ROUT2 correspond to Andrews' row of Table VII. The link labels in ROUT2 are the links to route packets on to get to the node given in Andrews' row. For example, packets destined for Gentile (ID of 4) from Andrews pass through Ft. Detrick. Where Andrews' row and Gentile's column intersect (in Table VII), Ft. Detrick is the node given to process the packet next. For Gentile being the packet's destination, parameter 1's value is a 4. The 4th entry in ROUT2, each entry separated by a slash, gives the label ANQL2 which is the link connecting Andrews and Ft. Detrick. If the value is a 1, the packet transfers to label ANK11, or if it is a 2, the packet transfers to the label TERM2 for local "delivery" (termination). As seen in the rest of the function, for each destination ID number (1 to 8), a label exists where the packet is transferred to. In the event a link contains more than one trunk, as in the link between Andrews and Ft. Detrick, ANQL2 (encircled "N", Appendix A), the individual trunk queue lengths are compared to queue the packet on the shorter of the two. If the packet is to be sent to Ft. Detrick, the output queue lengths (ANQ21 and ANQ22) are compared. If the length of ANQ21 is shorter than ANQ22, the packet is sent to label ANK21 (primary trunk to Ft. Detrick) otherwise it is sent to label ANK22 (secondary trunk to Pt. Detrick). Since the link to Tinker (ANQL4) contains two trunks, a similar process is used for trunk selection. For packets going to Albany or Hancock, they are sent directly

to the respective trunks (ANK11 or ANK31).

Locally terminating packets are sent to the label TERM2 (encircled "P", Appendix A) where the TABULATE instruction enters the packet's accumulated delay time (value in the packet's system time Parameter M1) in a table labeled RTIME (defined encircled "Q", Appendix A). The Table RTIME defines the system parameter to be tabulated (M1), the first boundary point (20), width of each intermediate table interval (20), and the total number of intervals in the table (200). For example, if a packet had accumulated 15 milliseconds of delay time, it would be tabulated in the first interval 0-20. another packet has amassed a total of 93 milliseconds (msec) of delay time, it would be tabulated in the table's interval 80 - 100. Table VIII is an example of a sample output of system table RTIME. The UPPER LIMIT column shows the upper limit of the intervals, that is, an upper limit of 20 represents the interval 0 - 20 msec, 60 represents the interval 41 - 60 and so on. The OBSERVED FREQUENCY column gives the total number of packets whose delay times are within the corresponding time interval. The other entries are self-explanatory. After the packet's delay time is tabulated in RTIME, the program tabulates the packet's delay time in other tables depending on the packet's priority and length as shown in the section of code at the encircled "R", Appendix A. The packet finally leaves the network by entering one of the TERMINATE instructions.

For non-priority packets, assume the packet's parameter

TABLE VIII

Example Output of System Delay Table RTIME

	ıts		Deviation From Mean	192.0-	-0.582		C	9	٦.	<u>.</u>	٠,	9	æ	9	CA	₹.	a)	~	φ,	7	۵,	4)	φ.	ဆ	ိ	3,325	-₹
	Sum of Arguments	000.00000	Multiple of Mean	0.192	0.384	ż	?	6	づ	i,	3	?	0	7	.	≉	9	ထ္	0	3	₹	9	ထ္	9	ૡ	₹	9
	iation	o,	Cumulative Remainder	63.10	₹(φ.	⇉	ٿ	0	٦.	~	ထ္	~	3	~	0	ထ္	⇉	ふ	٠,	ထ္	0	॰	7	7	7	ထ္
	Standard Dev	7	Cumulative Percentage	6.9	44.51	9.5	٠, د	0.7	5.9	7.8	5.2	7.1	0.2	6.4	9.3	6.0	2.1	3.5	4.	9•9	7.1	8. 0	8.3	α α	ထို့အ	8,8	9.1
	Mean Argument	C+0.+0T	Per Cent of Total	36.90	7.61	•	•	•	•	•	•	•	•	•	2.82	•		•	•	•	•	•	•	•	•	•	0.28
			Observed Frequency	131	27	9	12	7		21,		2		22		9	4	V	2	⇉	83	m	-	7	0	0	ч
TABLE RTIME	Entries in Table	755 TABLE RTIME	Upper Limit	50	07	09	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	00†	420	017	0947	7480

TABLE VIII (CONT'D)

TABLE RTIME

Deviation From Mean 3.599 3.780 3.962 4.144 4.326 4.689 4.689
Multiple of Mean 4.806 4.998 5.190 5.382 5.575 5.575 5.959
Cumulative Remainder 0.85 0.56 0.28 0.28 0.28 0.28
Cumulative Percentage 99.15 99.44 99.72 99.72 99.72
Per Cent of Total 0.00 0.28 0.28 0.28 0.00 0.00
Observed Frequency 0 1 0 0 0 0 1
Upper Limit 500 520 540 580 620 640

All remaining classes are zero.

l contains the value of 8 (Tinker's ID). Assume also after comparing trunk queue lengths, the packet transfers to ANK42 (encircled "S", Appendix A). The packet enters queue ANQ42 which corresponds to the 4th link, 2nd trunk queue. When the trunk ANTK5 is available, the packet seizes it and departs ANQ42. Depending on the packet's parameter 2 value, the packet is transferred to ANS42, if a short packet, to acquire 27 msec transmission time, or to ANIA2, if a long packet, to acquire 100 msec. The transmission times of 27 and 100 msec are derived by dividing the packet's length by the transmission speed of the trunk (56000 KBPS) plus a propagation factor of 7 msec. After acquiring the appropriate transmission time, the packet releases ANTK5 and transfers to Tinker's SCM 3, TNKR3, for further processing.

Running the Baseline Model

In any simulation, the first question to ask is "What exactly do I want the simulation model to show?" In the baseline simulation, and in the algorithm simulation, there are several items of interest such as mean packet delay, maximum packet delay, and adaptability (reaction characteristics) of the routing discipline to topological changes and traffic level fluctuations. The purpose of this section is to explain exactly how the baseline simulation model is run on the CDC CYBER 175 computer in order to show the items of interest detailed above. Due to time and resource constraints

only the traffic level is allowed to fluctuate. In the next chapter, the incorporation of the hierarchical routing algorithm is explained and both topological changes and traffic level fluctuations are simulated. The same procedure used in the baseline program to vary the traffic levels holds for the algorithm simulation model also.

Basically, the model is run for five seconds at 20% saturation in order to establish a steady-state system. The program is then allowed to run for thirty seconds, again at a 20% saturation. Thirty-five seconds into the simualtion, a traffic volume spike occurs for one second, then the traffic volume returns to the normal operating level of 20% of saturation and remains there for twenty more seconds. Four runs are made with the spiked traffic level being 60%, 70%, 80%, and 90% of network saturation. For each of the four runs statistics are output after thirty second continuous level of 20% saturation, after the one second burst, and once each second thereafter for the next twenty seconds. The reasoning behind so many statistic dumps is to show how the routing discipline (static in the baseline model, adaptive routing in the algorithm model) behaves after the one second traffic burst.

The operating system of the CYBER 175 allows remote terminals (CRTs and Texas Instrument's Silent-700 terminals) to access the main computer through a portion of the operating system called Intercom. Using a normal LOGIN procedure, the interactive user can create, manipulate, and save files

(usually programs) once into the Intercom portion of the operating system. The GPSS code for the baseline program was entered similarly and saved on permanent file. To make a set of computer runs, a copy of the baseline program is called into a file editor and made a local file (local as long as the Intercom session lasts) with the file name of say, DIN.

For a set of four runs, the only section of code altered is the section denoted at the encircled "T", Appendix A.

GPSS allows redefinition, or overlaying, of previously labeled instructions with new instructions labeled with the same label name. For the first run, (spiked traffic at 60% saturation), the code denoted by the encircled "U" is deleted from the edit buffer. The rest of the edit buffer which not only contains the code as shown in Appendix A for the Andrews node but also similar code for each of the other seven nodes in the network, is saved under another local file name (say, RUN1). Appropriate Intercom control commands are entered through the keyboard to start the compilation and execution of the program with the file name of RUN1. The file with the name DIN is then called back into the edit buffer to be modified for the second run. This time the section of code denoted by the encircled "V" is deleted from the edit buffer. The rest of the edit buffer is saved under a new local file name (say, RUN2). Again appropriate Intercom control commands are entered to start the compilation and execution of the program with the file name of RUN2. Similarly,

for the 3rd and 4th runs DIN is called back into the edit buffer and changed appropriately following the same procedure as outlined above but removing only those sections of code not relating to spiked traffic level of interest.

During execution, the time-controlling portion of code is denoted by the encircled "W", Appendix A, and each of the remaining START instructions. Each time unit in the simulation program is considered to be one millisecond (msec). Thus the GENERATE 1000 instruction generates one transaction per 1000 msecs or one second. The first operand of a START instruction is stored by the GPSS simulation control processor and acts like a time-control counter. After a second of simulation time, the GENERATE 1000 instruction generates a transaction which immediately enters the TERMINATE 1 instruction. The "1" of the TERMINATE instruction subtracts one from the time-control counter. If the counter's value is zero that portion of the simulation is ended. If it is not zero, the simulation runs for another second, the GENERATE 1000 instruction generates another transaction which immediately enters the TERMINATE 1 instruction. One is subtracted from the time-control counter. If the counter is zero, the simulation ends, if not zero, the simulation runs for another second. When the counter reaches zero. the GPSS simulation processor scans the following instructions until it finds another START instruction or the END instruction. If the simulation processor finds labeled instructions between START instructions, the processor overlays the existing

instructions with the same labels in the main portion of the program with the new instructions. This is how the traffic intensity levels are changed in the simulation. The different mean interarrival times in the labeled GENERATE instructions come from Table IV. When the END instruction is encountered, the simulation is ended.

In words, the execution of the program (for the 60% spike) is as follows: At the start of the execution, the simulation clock is set to zero. Execution begins and packets are generated in the main body of the program moving through the network code as instructed. Also at time 0, the GPSS control processor scans down to the first START instruction (START 5. NP) where the NP stands for no statistics printout after this section of the simulation ends. The timecontrol counter is set to 5 and execution actually starts. After one second, the GENERATE 1000 instruction (encircled "W"), generates a transaction which immediately enters the TERMINATE 1 instruction. One is subtracted from the timecontrol counter. If non-zero, simulation continues, if zero, statistics are output and the GPSS processor scans down to the next START instruction (START 30,,30). The RESET instruction clears all the statistics accumulated except for those involving facilities (SCM processors and the trunks) and queues (SCM processor input queues and the trunk queues). The first "30" of the START instruction sets the time-control counter to 30. The second "30" informs the GPSS processor to generate output statistics after 30 transaction terminations

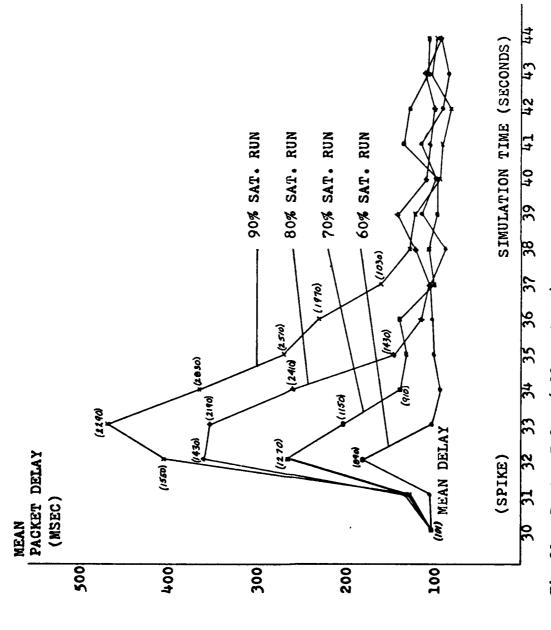
(30 seconds). After 30 more seconds of simulation time, the statistics requested are output and the GPSS control processor scans down to the next START card (START 01,,01). instructions labeled ALBAN through TINKE in the selection of code denoted by the encircled "X", Appendix A, replaces the instructions under the same label name in the main program. The packet generating instruction in each of the node's code is modified to generate packets at 60% saturation rate. The RESET instruction clears all the statistics except for those given in the instruction. The modified program runs for one second, terminates and statistics are output. GPSS control processor scans down to the next START instruction (START 1,.1). The instructions denoted by the encircled "Y" are used to reestablish the original packet generation intensity of 20% saturation. The statistics are reset and execution begins again. This procedure occurs again and again until the END instruction is encountered and the complete simulation ends. It should be noted that when a time interval elapses, the status of the model, that is, the number of packets in the queues and packet positions throughout the model does not change. The RESET instruction clears only the appropriate tables (statistics).

Baseline Results

The results of the baseline simulation are of no real importance except to get a feel of how the basic model operates. Items of interest are the mean packet delay, maximum packet delay and (to see) how these values change when

the traffic intensity increases. In the next chapter these results are compared against similar algorithm model runs to get a feel of the algorithm operation.

The best way to show the results is in the form of graphs. Specific data relative to the above mentioned items of interest are extracted manually from the simulation statistic outputs and put together to form five illustrations, three graphs and two tables. The statistical output data starts at the 30 second time interval. The mean delay value of the 30 second time mark (in parenthesis on the graphs) is the mean packet delay over a 30 second simulation time period during which the system has reached equilibrium. Figure 22 shows the graphical results of data taken from the system delay table, RTIME, for each of the four simulation runs. Also shown in Figure 22 are the significant maximum packet delay times encountered for each run (in parentheses on the graph). These values indicate that during the time interval in which the statistics were taken, a packet terminated having the delay time indicated in parentheses. Figure 23 shows the results of data taken from the non-priority - short packet delay table, RTLOS, along with the significant maximum delay times. Figure 24 shows the results of data taken from the non-priority - long packet delay table, RTLOL, and the associated significant delay times. Since only 1% of the packets generated as priority packets, the data on the priority short and long packets are not completely representative. The number of priority packets generated in the



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Fig 22. System Delay (all packets)

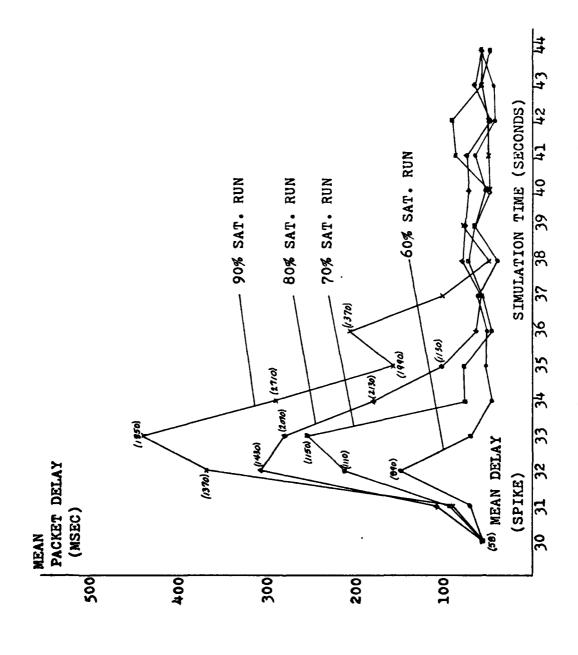


Fig 23. System Delay (non-priority - short packets)

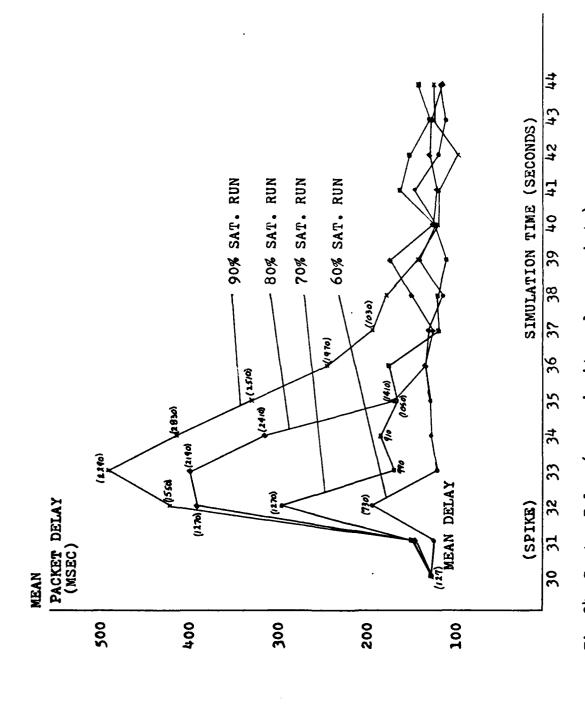


Fig 24. System Delay (non-priority - long packets)

one second time intervals is so small as to infer incorrect mean delay times if shown in graphical form. During some of the one second time intervals, only one priority - short packet is generated and in the other one second time intervals only one priority - long packet is generated. In some of the one second time intervals, no priority packets were generated at all: The best way to show these types of results is in tabular format. Table IX contains data extracted from the statistical outputs for priority - short packets, and Table X shows the data extracted for priority - long packets.

Figure 25 contains information on packet delays extracted from DCA's System Performance Specifications (Ref 19) for the AUTODIN II network.

Category Type	Catego (Prior	ory I city)	IĬI	y I II IV iority)
	Mean (msec)	Max (msec)	Mean (msec)	Max (msec)
Short Packets (1120 bits)	180	580	380	1350
Long Packets (5224 bits)	330	730	530	1500

Fig 25. AUTODIN II Packet Delay Specifications

The delays shown are for the two-hop case, that is, packets are assumed to traverse a source, tandem, and destination node, and SCM processors are operating at eighty per cent utilization (Ref 19:43). The maximum is defined to be the 99th percentile of delivery delay distribution (Ref 19:43), that is, one tenth of one per cent of the packets

TABLE IX

System Delay (priority - short packets)

Simulation Time		Delay	Delay Times (milliseconds	llisecor	ıds			
(seconds)	60% Sat. Mean	Run Max	70% Sat. Mean	Run Max	80% Sat. Mean	Run Max	90% Sat. Mean	Run Max
30	67	110	64	110	64	110	64	110
31 (spike time)	122	390	80	ဆ	112	130	111	110
32	ı	8	٣	٣	ı		,	
33	154	154	33	33	119	190	,	
34	9	9	ı	1	•	. 1	1	•
35	39	39	ı			ı	18	30
36	1	1	ı		1	•		
37	33	33	ı	1	63	63	•	
38	1	1	ı		36	36	σ	~
39	1	1		i	ı	ı		٠,
O+;	ŧ	ì	33	33	٣	6	ı	ı
41	ı	•	ı		ı	ı	1	ı
775	1	1	99	130	•		84	50
£43	18	30	1	,	1	ı	18	30,
77	•	1	18	30	09	06	ı	1

TABLE X

System Delay (priority - long packets)

Simulation			Delay Ti	mes (m1)	Delay Times (milliseconds)	~		
(seconds)	60% Sat. Mean	Run Max	70% Sat. Mean	Run Max	80% Sat. Mean	Run Max	90% Sat. Mean	Run Max
30	130	310	130	310	130	310	130	310
31 (spike time)	236	390	109	210	154	210	159	170
32	258	310	ı	ı	155	310	509	270
33	3	2	•	ı	•	ı	167	230
34	3	در	114	130	162	210	901	106
35	150	230	•	ı	3	٣	124	250
36	6	٣	108	110		ı	127	150
37	ı		160	160	901	210	73	110
. 38	124	124	158	210	1	ı	509	209
39	89	170	509	508	•	ı	106	106
04	ı		20	210	204	210	72	210
41	55	110	106	110	1		901	901
42	108	108	107	210	٣	٣	ı	
43	191	161	1	1	176	210	193	193
ተተ	٣	3	ı	ı	•	•	٣	3

in the system are allowed to incur a delay not to exceed the maximum values given in Figure 25.

In the steady-state condition (the first 30 seconds of the simulation), the delay times accorded packets are well within the specifications given in Figure 25. However, when traffic intensity spikes occur, specifically the 80% and 90% spikes, both mean and maximum delay values are exceeded (in the time frames immediately after the spike). The DCA Performance Specifications do not list any concrete behavioral characteristics the routing algorithm should provide other than it should recognize network degradations and react efficiently to compensate for traffic volume fluctuations. As seen in the graphs, the baseline static routing discipline smoothes back out to an average delay value of about 100 milliseconds within six seconds after the spike occurs. This six second time span may or may not be acceptable considering this simulation is only concerned with a control simulation model.

These results, performance characteristics and the values given in Figure 25 take on a more significant meaning in the next chapter. The whole purpose of this paper is shown in the next chapter which explains how the hierarchical routing algorithm is incorporated into the baseline simulation model. The algorithm simulation program illustrates the adaptability of the algorithm by varying the traffic intensities while topological changes occur.

VII Algorithm Description

As stated in the previous chapter, the basic model and the simulation code of the baseline program remains the same for the algorithm version of the program. The differences are the addition of Fortran subroutines representing the routing algorithm and the addition of GPSS instructions necessary to activate the Fortran subroutines as well as the GPSS code necessary to pass numerical data to the subroutines. Since the algorithm "Background Functions" require periodic entry into some of the subroutines, additional simulation code is added to facilitate these periodic entries.

This chapter explains how the Fortran versions of the algorithm's modules are written and how they merge with the baseline program. The GPSS changes necessary to accomplish and support the new program are also explained. In addition, the chapter explains exactly how the new program is run with respect to normal network configuration, that is, all nodes, links, and trunks operational. The final section of this program explains how pre-selected trunks, links, and nodes are removed from the network and how the algorithm compensates for the degradation.

Fortran Subroutines for Modules

Each module of the algorithm, MINHOP, RTABLE, PAKROUTE, MESGEN, and UPDATE, is coded in Fortran with each node of the network maintaining its own copy of the algorithm. Each

module has its own Fortran subroutine counterpart except MINHOP. There are four subroutines composing MINHOP: INITIALIZE (same as CONNECTIVITY described in Chapter IV), INITIALIZE_D, COMPUT_D, and CONN_CHANGE. Appendix B represents Ft. Detrick's version of the algorithm. The module names and their corresponding subroutine names are the following:

(1) MINHOP

INITIALIZE - DEINIT

INITIALIZE_D - DEINID

COMPUTE_D - DECOMD

CONN_CHANGE - DECCHG

- (2) RTABLE DERTBL
- (3) PAKROUTE DEPKRT
- (4) MESGEN DEMSGN
- (5) UPDATE DEUPDT

The COMMON/DETABL/ statement, and the following
INTEGER and REAL statements denoted by the encircled "A" in
Appendix B contain the algorithm database. The block is
in common with each subroutine since each subroutine uses
and modifies the algorithm's tables, arrays, variables and
constants contained in the block. The names used are as
close as possible to the names used in the module flowcharts in Chapter IV. Each name is prefixed with "DE"
to denote Pt. Detrick. Each of the other nodes has almost
the identical code written for them. What differentiates

one node's code from the other is the first two letters in each name. Albany's code is prefixed with the letters "AL", Andrews "AN", Gentile "GE", Hancock "HA", McClellan "MC", Norton "NO", and Tinker "TI". Other differences are the arrays XXLINS and XXBFID. The values of the XXLINS array (DELINS for Ft. Detrick - encircled "B" of Appendix B), are the numbers of trunks within a particular link indexed by that link. For example, link number 1 contains 3 trunks and link number 4 contains 1 trunk. Since each node does not have the same number of links or trunks, the array is different for each node. The values of the other array, XXBFID (DEBFID for Ft. Detrick - encircled "C" of Appendix B), are the trunk numbers of the first trunk in a particular link indexed by that link. For example, the first trunk in link 2 is trunk number 4 and the first trunk in link number 4 is trunk number 9. The last two differences are the local node's ID number (DESELF = 3 for Ft. Detrick encircled "D" of Appendix B), and the node saturation threshold XXT2 (DET2 for Ft. Detrick - encircled "E" of Appendix B). Each node does not have the same number of SCM processors. Hence the number of packets on input queue for a one-processor putting it into saturation would not put a three-processor node into saturation since its input queue can, in effect, hold three times the number of packets. Thus the saturation threshold for one-processor nodes is lower than that of the three-processor node. For single processor nodes the threshold is 12, for dual-processor nodes it is 18, and for triple-processor nodes the threshold is 20. For a more detailed definition of the names used in the subroutines see Appendix C. The names in Appendix C are for the Ft. Detrick node but can be extended to the other nodes by adding the appropriate prefix.

The arguments of the subroutine call and their declarations (encircled "F" of Appendix B) are required, in the order shown, by GPSS. In the main GPSS simulation program the packet's source node ID, destination node ID, priority status and length are stored in parameters associated with that packet. Also stored in the main program (in the SAVEVALUES), are the output trunk queue lengths. The values are passed to the Fortran subroutine via the arguments of the subroutine call. The packet's parameters are passed through the named PARMVA and the queue lengths are passed through the name SAVVXX (SAVVDE for Ft. Detrick). More explanation of the passed values is given in the next section of this chapter.

After the 64 (8 nodes of 8 subroutines each) subroutines are written, they are compiled as one large program and a single relocatable binary file produced. The filename is an input parameter for the command to execute the GPSS simulation program. Before execution starts, the binary file is loaded into the core and the subroutine names compared against all the subroutine calls in the main simulation.

Simulation Program Modifications

GPSS HELP Blocks. The instructions GPSS provides to communicate with Fortran subroutines are called HELP instructions. Their format is HELPX A. B. C. D. E. F. G. where X is one of A, B, or C, and A through G are the operands. Operand A is the name of the subroutine and B through G are the values passed. HELPA instructions provide one-way communication to Fortran subroutines, that is, the values passed to the subroutine can only be read. HELPB instructions provide for two-way communications. The values passed are the contents of the SAVEVALUEs explicitly given in the operands B through G which can be read or changed in the subroutine. HELPC is a very special instruction. Not only does it provide two-way communication but it also makes all the GPSS internal system tables and arrays plus all the attributes concerning queues, facilities, SAVEVALUES, and user defined TABLEs available for use and modification by the Fortran subroutine. The B-G operands are read-only but the system values can be read and/or modified. The system values are not passed as arguments in the subroutine call but rather made accessible to the subroutine (see encircled "F" in Appendix B). The order of definition in the subroutine must be the same as shown in the encircled "E" portion because this order is the way the internal tables, arrays, etc. are laid out in core. Any scrambling of the order results in chaos if the values are referenced then modified. There is no control program checking to ensure proper referencing and

usage of the system values.

Algorithm Activation. Appendix D is the complete GPSS simulation program which incorporates the hierarchical routing algorithm. There are essentially seven sections to the program. Sections 1 and 7 make up the original baseline program with minor changes and is called the main program. Sections 2 and 3 provide the necessary periodic entry in the MESGEN subroutine at each of the nodes. Section 2 handles the entry into MESGEN on the FTICK (to check "Bad News") interval, every 100 milliseconds, and Section 3 handles the entry into MESGEN on the STICK (to check "Good News") interval, every 400 milliseconds. Section 4 provides periodic entry (every 100 milliseconds) into the RTABLE subroutine at each of the nodes. Sections 3 and 4 use portions of Section 2's code in order to reduce redundancy of code. Initialization of all the algorithm's tables, arrays, constants, and flags are accomplished by Section 5. When topological changes are required, Section 6 is added. The code of Sections 1 through 5 remains the same throughout all the simulation runs. It is Section 6 that gets changed whenever a topological change is desired. A more detailed discussion about the way the changes are accomplished is given in a later section of this chapter. Section 7, as in the baseline program, is the simulation timing control section. As explained in Chapter VI, it controls the traffic volume intensity levels and statistical output. The order of discussion for the sections is Section 5, Section 2, Section 3,

Section 4, and Section 1.

As stated earlier, Section 5 initializes all the tables, arrays, constants and flags used by the algorithm as a whole by activating the INITIALIZE, INITIALIZE_D, COMPUTE_D, and RTABLE subroutines for each of the nodes. The GENERATE instruction generates only one transaction (packet). The purpose of the packet is to move through the various HELP instructions activating the subroutine whose name is the A operand of the instruction. The B through G operands (Pl to P6 are the values of the parameters 1 to 6 of the packet but are used only for dummy arguments because of the instruction format. The moves through the HELP instructions starts at those given for Albany and terminates at the TERM-INATE instruction after activating Tinker's initializing subroutines. The packet does not move on to the next HELP instruction until the present subroutine that it has activated is completed.

Section 2 gives the code necessary to enter MESGEN under the FTICK periodic interval. The code denoted by the encircled "A" generates a packet every 103 milliseconds, assigns priority status (parameter 2 = 2) and assigns the special status packet length of 389 bits (parameter 3 = 3) to the packet. The reason for generating a packet every 103 msec instead of exactly 100 msec is to help ensure that not more than one status packet is being processed by the same section of code at the same time. The packet enters the SPLIT block labeled ALBME where a duplicate packet

with the same parameter values is generated. One packet goes to the label ANDME (Andrews' equivalent MESGEN code). The first instruction at each of the other node's MESGEN code is a split instruction which sends another copy of the packet to the next succeeding node's MESGEN code for their processing. In this fashion, the MESGEN section of simulation code at each node is executed almost simultaneously. SAVEVALUE 122 is set to a value of one (denoting "BAD NEWS" processing in Albany's MESGEN subroutine ALMSGN). The sequence of instructions QUEUE, SEIZE, DEPART, and RE-LEASE is used to ensure the execution of the code denoted by the encircled "B" by only one status packet at a time. The packet has Albany assigned as the source node (parameter 4 = 1) and SAVEVALUE 125 is set to the value 0. The HELPC ALMSGN block is entered next to activate Albany's MESGEN subroutine. If the subroutine has in fact generated a status packet, (SAVEVALUES 57 - 64 contain Albany's status packet information), then the value of SAVEVALUE 125 is changed from its previous value of 0 to a value of 1. If ALMSGN has changed the value of SAVEVALUE 125, the TEST L instruction sends the packet to the instruction labeled ALBNY. If no status packet information was generated by ALMSGN, the packet terminates. Whenever the MESGEN determines a status packet is necessary, SAVEVALUEs are used to store the actual information. The status information is not actually assigned to the packet which activated the MESGEN subroutine. The packets purpose is only to activate the appropriate subroutine

to manipulate (read or modify) the contents of the SAVE-VALUEs which represent status packet information. Assume status packet information is generated, the packet enters the instruction labeled ALBNY where a duplicate copy is sent to the instruction labeled ANDWl. The original packet falls through to the ASSIGN statement where parameter 1 is loaded with Albany's ID as the destination node. At ALMEL, the sequence of instructions QUEUE, SEIZE, DEPART, and RE-LEASE is used to ensure the execution of the code denoted by the encircled "C" and is executed by only one packet at a time. Because status information was generated, the algorithm's database must be updated to reflect the new current information. The HELPC ALUPDT instruction activates Albany's version of UPDATE to update Albany's LD matrix with the information contained in SAVEVALUES 57 - 64. The HELPA ALINID and HELPA ALCOMN recomputes Albany's D table and associated arrays. At ALME2, a similar instruction sequence to inhibit simultaneous processing of packets is executed. The packet enters the HELPC ALRTBL instruction which activates Albany's version of the RTABLE subroutine. Link routing arrays SROUTE and ROUTE are then recalculated. Having accomplished its intended purpose and no longer needed at the Albany node, the packet enters the TERMINATE block denoted by the encircled "D" and is removed from the system.

Albany has now processed its own status packet information but the other nodes also need to process Albany's status information. The SPLIT instruction labeled ALBME

had previously sent a packet to the instruction labeled ANDWl. In the code denoted by the encircled "E", a packet is generated for each of the other nodes with the appropriate destination node's ID number assigned to parameter 1 of that packet. Each packet is transferred to be input processed as any other packet is processed.

As indicated earlier in this section, MESGEN processing is identical for each of the nodes. The portion of code from ALBME down to and including the encircled "E" is duplicated for each node. The only changes in code are the SAVEVALUE instructions. Each node has its own set of SAVEVALUES. A complete listing of the SAVEVALUES and those Assigned to each node is given in Appendix E.

Section 3 enables the periodic entry into MESGEN for each of the nodes under STICK time interval. In order to reduce the chances of attempting to process two status packets at the same time, packets are generated every 401 msec instead of the advertised 400 msec. As in the FTICK code, the packet is assigned priority status (parameter 2 = 2) and the unique packet length of 389 bits (parameter 3 = 3). At ALBY (for Albany), a duplicate packet is sent to ANDE (for Andrews) while the original packet falls through into the SAVEVALUE instruction. SAVEVALUE 122 is set to zero to denote "GOOD NEWS" processing at Albany and the packet is transferred to ALBM1 (in the previous FTICK coding). The processing of the packet is identical to that of the previous packet processing discussion only the SAVEVALUE 122

value of 0 causes the MESGEN code to check for new operational links and the absence of link congestion or node saturation (GOOD NEWS). The rest of the code in Section 3 sets the appropriate SAVEVALUES to zero for each of the respective nodes then transfers the packets to the proper entry point in each node's FTICK coding.

Periodic entry into the RTABLE subroutines at the various nodes is accomplished in Section 4. Packets are generated every 100 milliseconds and since these packets are not transmitted no values are assigned to any of their parameters. The sole purpose of a packet generated in this section is to cause the activation of a node's RTABLE subroutine. After generation, a packet enters the SPLIT instruction labeled ALBN (for Albany) whereupon a duplicate copy is sent to ANDS (for Andrews). The original packet falls through to the TRANSFER instruction and is transferred to ALME2 (in the previous FTICK code). The rest of Section 4's code creates and transfers packets to the respective entry points in that node's code to activate the appropriate RTABLE subroutine.

Now that the activation of the algorithm's Background subroutines have been discussed, changes to the main simulation program, Section 1, will be explained. Since each node requires the same general changes, the changes necessary for Albany's code are explained. The first required change comes as a requirement to activate Albany's PAKROUTE subroutine. The encircled "F" shows the code necessary to activate and use the results of the subroutine Pl through P6

(parameters 1 through 6 of the packet), which contain all the necessary information needed by the subroutine to select the trunk over which to route the packet. When the packet enters the HELPC ALPKRT instruction, the subroutine uses the values of P1 (destination node ID) and P4 (source node ID) in the calculation to select the best trunk. The selected trunk's ID number is stored in the FULLWORD SAVEVALUE 1. When control is returned to the GPSS simulation program, the packet enters the following ASSIGN block. The trunk ID number in FULLWORD SAVEVALUE 1 is assigned to packet parameter 5. The TRANSFER block uses the value of parameter 5 and FUNCTION ROUT1 to transfer the packet to the correct trunk queue.

Changes are also required to the ROUTl function, encircled "G". Packets can be sent to any one of Albany's seven
trunks, terminated locally or be removed from the system because the packet is undeliverable (the destination node of
the packet is non-operational). Thus nine entries are required in the function. PAKROUTE returns one of nine numbers
(1 - 9) to be placed in parameter 5 of the packet. If the
packet value is 1 through 7, the packet is sent to the indicated trunk for transmission. If the value is an 8, the packet is sent to TERM1 for local termination processing, and
if the value is a 9, the packet is undeliverable and is sent
to a terminate block for removal from the system. Local
termination processing, indicated by the encircled "H", includes changes to the program to check and see if the packet
represents a status packet. The packet's length is checked

to see if the length corresponds to the length of a status packet. If it does, the packet is transferred to ALME1 where, the packet causes activation of Albany's UPDATE subroutine. Inside of Albany's UPDATE subroutine, ALUPDT, the correct set of SAVEVALUES, containing the new status information for the node whose status packet is being processed, is accomplished by a calculation using the packet's source node ID number. After UPDATE, the same packet causes execution of INITIALIZE_D, COMPUTE_D, and RTABLE to recalculate and update the algorithm's database then terminates.

Since status packets are being transmitted through the network, changes are required to the portion of code representing the transmission of packets. For example, a status packet from Albany is to be transmitted to Ft. Detrick (denoted by the encircled "I"). The packet enters the queue ALQ22, seizes the trunk ALTK3, and departs the queue. To determine how much transmission time is required for the packet, parameter 3 (containing the length of the packet) and FUNCTION ALF22 (denoted by the encircled "J") is used. Since the value of parameter 3 is a 3, the packet is sent to ALC22 where the packet accumulates 16 msec of transmission time. After acquiring the specified amount of time, the packet releases the trunk, ALTK3, and is transferred to the second SCM processor at Ft. Detrick (FTDE2) for further processing.

Procedures for Running the Modified Program

The first set of four runs is with the network totally operational, that is, all trunks, links, and nodes up and functioning. The same method of running the baseline program with one run per traffic intensity spike of 60%, 70%, 80%, and 90% of network saturation is used for running the algorithm version of the simulation program. Appendix F shows the graphical and tabular results of this first set of simulation runs.

The program code used to simulate the network losses is the portion of the main program code with the comment title, "CODE FOR ENTRY INTO CONNECTIVITY CHANGE" (Section 6), and the algorithm's CONN_CHANGE subroutine. A discussion is given detailing the program changes required for each of the different types of network losses. For ease of explanation, one specific example is discussed in each of the three types of topological changes.

Trunk Loss Simulation. Figure 26 shows the code of the main program necessary to drop the third trunk in the Albany - Ft. Detrick link. There are two parts of code in Figure 26. Part 1 generates one packet 25 seconds into the simulation. The packet is assigned priority status and the length of a status packet. An identical packet, including the same parameter values, is created in the SPLIT block (denoted by the encircled "A") and sent to label SECPR. The original packet falls

through into the SAVEVALUE instructions where SAVEVALUES 121, 126, and 127 are loaded with values used in ALCCHG, Albany's CONN_CHANGE subroutine (Figure 27). Zero is loaded into SAVEVALUES 121 and 126 to set flags to denote a change in trunk status and that a trunk is to be dropped respectively. One in SAVEVALUE 122 sets the flag to denote "BAD NEWS" processing is to occur in Albany's version of MESGEN after the return from ALCCHG. A two in SAVEVALUE 127 indicates that a trunk will be dropped in Albany's link 2 to Ft. Detrick. The HELPC ALCCHG instruction causes control to be passed to the ALCCHG subroutine. In the subroutine, control is passed from statement 4 to statement 100. The ALLINS array is used to store the number of trunks in a particular link indexed by that link number. Since SAVEVALUE 126 has a 0 in it, control is passed to the next statement where a 2 is stored into ALLINS (2). Originally there were three trunks in link 2 to Ft. Detrick, but now there are two, in effect dropping a trunk from the link. Control is returned to the GPSS simulation program and the packet is transferred to a portion of code in Section 2. MESGEN is entered to see if dropping of the trunk requires the generation of new status information. If not, the packet is removed from the system. Otherwise its further processing is as described earlier in reference to the processing of a status packet. Similar processing goes on starting at label SECPR, encircled "B", Figure 26, to simulate Ft. Detrick's dropping of a trunk in its link to Albany.

CODE FOR ENTRY INTO SON JECTIVITY CHANGE

FOR THIS SIMULATION, CONP-CHANGE IS USED TO CHANGE THE STATUS
OF TRUNKS OR LINES DEPENDING ON THE CODE DELOW.
FOR TRUNK LOSS, A SAVEVALUE FOR PARTICULAR NODE IS SET WITH THE
LINE # IN MHICH A PARTICULAR TYDING OR ADD.
THE TRUNK PACK IT THE FLAS IS OR I RESPECTIVELY.
FUR LOSS, ANOTHER SAVENDING ON THE SAVENDING RADD.
THE LINE ADD.
FUR LOSS, ANOTHER SAVENDING ON THE SAVENDUE NUMBER OF
THE LINE TO BE DATASED. DEFENDING ON THE SAVENDUE
HISTO TO FALG LINE CHANGE, THE LINE OF OPPED UR
ADD.
FUR LOSS IN CHANGE TO BE SAVENDING ON THE SAVENDUE THAT IS USED FOR
LINE COMMENTS ON THE INSTRUCTIONS THEMSELVES BETTER
CLARITY MAT ACTION IS TAKING PLACE.
IN AN FFECRI TO SAVE CODE, THE SAME SAVEVALUE THAT IS USED FOR
LINE SAVEVALUE IS USET TO SISNAL THE PARTICULAR TYPE UF PROCESSING IN MESCEN TO 35 ACCOMPLISHED.
SING IN MESCEN TO 35 ACCOMPLISHED.
SINGLINE SAVEVALUE IS SHELF DUDLEX, THAT IS TRAFFIC PASSES
COMING AND GOING ON THE SAME THOMK. RESPECTIVE CONN-CHANGE
SURACUTINES MUST BE WITHED BY NOTESTION.
OF THE "TRUNK" OR LINK IN NODES WHO ARE CONNECTED TOGETHER.
OF THE "TRUNK" OR LINK IN NODES WHO ARE CONNECTED TOGETHER.

1ST EXAMPLE - DROP 4TH TRUNK AT ALBANY AND THE CORRESPONDING TRUNK AT FT. DEIKICK.

Section 6

7 1	GENERATE	25400,,25062,1,,,F GE	GENERATE 25000, 25002, 1,, F GERERATE 1 PACKET 25 SECS INTO SIMULATION.
	PAIOHITY	2 61VE	IT PRIORITY CLASSIFICATION.
	A 35 I G 4		SET PARAMETER 2 WITH THE PACKET PRIORITY.
•	ASSIGN	3,3 SET P.	ARA, 3 WITH THE SPECIAL STAF, PKT LENGTH.
€	SPLIT	1, SECPR SEND	COPY FOR 2ND MODE PROCESSING.
ı	SAVEVALUE	د.	SET FLAG FOR THUNK LOSS.
	SAVEVALUE		LAG FOR MAN NEWS PROSESSING.
	SAVEVALUE		TO DROP TRUNK.
	SAVEVALUE	127,2,XL DEOP	TRUIK 4 DT ALBANY.
		ALCCHG, P1, P2, P3, P4, P4	ALCCHG, P1, P2, P3, P4, P1, P4 G0 DRUP TRIJAK.
•		, ALBM1 GC SE	F 13 STAT. MSG. 15 NECOESSARY.
SECP B	B SECPR SAVEVILUE	14096, XL SET FI	LAG FUR TRUNK LOSK.
ı	SAVEVALUE	141,1, XL SFT FI	LAG FOR BAD NEWS PROCESSING.
	SAVEVAL'1E 146,0, XL	146,0,0 XL FLAG	FLAG TO DROP TRUIK.
	SAVEVALUE		TRUNK S AT FT. OFTRICK.

- Ft. Detrick Link to Drop Trunk in Albany Code Necessary

Part 2		HELPC TRANSFER GENERATE PRIDFITY ASSIGN SSSIGN CPLIT SAVEVALUE SAVEVALUE	DECCHG,P1,P2,P3,P4,P5,P6 GO DRUP TRUNK. DETM1 GO SEE IF STAT. MSG. IS NECCESSARY. - KEISTAPLISH 3KD TRUNK AT ALBANY AND THE CORRESPONDING TRUNK AT FT. DETGLCK. 46000.,460C2,1,.,F GFN. 1 PACKET 46 SFCONUS INTO SIMULATION. 2.2 2.2 SET PAKA-4FTER 2 WITH PRIORITY. 3.3 SET PAKA-4FTER 2 WITH PRIORITY. 3.3 SET PAKA-4FTER 2 WITH PRIORITY. 3.5 SET PAKA-6FTER 2 WITH SPECIAL STAT. MSG. LENGTH. 122CP1 SET FLAG FOR TRUNK ADD. 122.6.XL SET FLAG FOR GOOD MEWS PRIOFSSING.
Ø	SECP1		12U,1,XL FLAG TO ADD TRUMK AACK. ALCCHG,P1,P2,P3,P4,P5,P6 GO ADD TRUMK. ,ALEM1 140,U,XL SET FLAG FOW TRUNK ADD. 141,C,XL SET FLAG FOW TRUNK ADD. 145,C,XL SET FLAG FOW GOUD WEWS PROCESSING. 145,1,XL FLAG TO ADD TRUMK 9,CX. DECCHG,P1,P2,P3,P4,F5,P6 GO ADD TRUMK.

```
CO-1P-OR/ALTP-L/ALLD(6,3), 41 P(9), INFI, 41 MU, ALNG(72), ALRJU1(3), #ALJ(3,6), AL FOP (8), ALLIS (1,2), ALSELF, ALNLM, ALS, ALE, ALS-201(8), #ALLI 45 (4), ALGOFF (4), ALPOFT (2), ALPFID(1), ALPARM(6), ALGUP (4), ALZONE, #ALTI, ALT2, AISTUS(4)
                                                                                                                                                                                                                                                                           INTESER PAPMVA(5), BLO(2,1), VAK(1), FUN(2,1), BVA(1), CHA(3,1)
INTESER FAC(5,1), GRO(1), HSA(1), LOC(1), PUE(4,1), STO(7,1), TAR(9,1)
INTESER FMA(1), FSA(1), HHA(1), BHA(1), LMA(1), BSA(1)
                                                                               CO.M.-CMANGE UPOATES THE NC TARLE TO REFLECT IF A LINK MAS CUME UP OR CONE DOWN. THE APPROPRIATE LINK CONNECTIVITY FATAY FCR (N.1,N.2) IS UPDATED TO DENUTE THE NEW CONNECTIVITY STATUS OF THAT LINK, MESGEN AND UFDATE (WHICH CALL MINHOP AND REALEST THIS NEW LINK
SUBACULTIVE ALCCHG(PARHVA, BLO, VAK, FUN, BVA, CHA, FAC, GRO, HSA, LOG, FQUE, STO, TAM, FMA, FSA, H4A, BMA, LMA, BSA, SAVVAL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  INTEGG & ALS, ALNO, ALP, ALP, ALHOP, ALLIST, ALBFID, ALGUP, ALNI,
*ALSELF, ALNIT, ALF, ALROJT, ALSRUT, ALINS, ALRUFF, ALGUFT, ALPARY,
*ALV2, ALV3, ALS, ALS, ALZOVF, ALTI, ALT2, ALSTAT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ALLD (AL '11, AI N2) = ALSTAT . ASSTALLD(ALN1, ALN2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        AL 42 = TAPS (ALNC (INDER + (INT (SAVVAL (127)))))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         GO TO 11C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (INT(SAVVAL(120)) . GT. 0) GO TO 15
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Œ.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (THT(SAVVAL(121)) . NE. 0) GO TO
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        AL 3117 (THT (ST VVAL (127))) = 1000
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (INT(SAVVAL(126)) .GT. 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              AL3119 (THT (SAVVAL (1271)) = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (ALH2 "HF" ALH3) 53 TO
ALHC(T) = ALSTAT * ALM3
GO TO 1333
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ALLINS (INT (CAVVAL (127)))
                                                                                                                                                                                                                        CONVECTIVITY STATUS.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          INJEX = ALP(ALSELF) - 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ALMS = IAMS(ALNC(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      a 41 F (4LN1) - 1
                                                                                                                                                                                                                                                                                                                                                               REAL SAVIAL (1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ALV1 = ALSFLF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ALSTAT = -1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ALSTAT = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          11)
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1030
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Albany's CONN_CHANGE Subroutine

Fig

In order to bring the trunks back up to operational status at Albany and Ft. Detrick, the code in Part 2. Figure 26, is exercized. Forty-six seconds into the simulation, a packet is generated (the trunks have been down for twenty-one seconds). The packet is assigned priority status, given status packet length, and a duplicate copy created and sent to label SECPl. The only change in the SAVEVALUEs is to SAVEVALUE 122 and 126. SAVEVALUE 122 is loaded with a zero to denote "GOOD NEWS" processing is to occur when MESGEN is entered in later code. SAVEVALUE 126 is loaded with a one to flag, in the ALCCHG subroutine, the reestablishment of the dropped trunk back into the link between Albany and Ft. Detrick. SAVEVALUEs retain their values throughout and the simulation unless specifically changed, hence no need to change SAVEVALUE 127. When the ALCCHG subroutine is activated by the packet entering the HELPC ALCOHG instruction, the values of ALLINS (2) is changed back to a three, essentially bringing the trunk back up to operational status. When control returns to the GPSS simulation the packet transfers to the same portion of code in Section 2 and is processed similarly as described earlier.

The duplicate copy of the packet sent to SECP1, encircled "C", Figure 26, accomplishes for Ft. Detrick the same job as the packet did for Albany. The trunk at Ft. Detrick returns as one of the three operational trunks in the link to Albany and Ft. Detrick's version of MESGEN is entered to determine if new status information should be generated.

Link Loss Simulation. In this set of examples, program changes to Section 6 of the main program are made to facillitate simulating the loss of a link between two nodes. Again, for use of explanation, the specific example of losing the link connecting Gentile and Ft. Detrick is used. Figure 28 shows the code necessary to simulate the condition. As in the trunk example, there are two parts to Section 6. Part 1 is the code used in simulating the loss of the link, and Part 2 is the code used to bring the link back up. The packet is processed in similar fashion as described in the trunk loss example above with exceptions in values stored in SAVEVALUEs. Gentile's version of CONN_CHANGE (GECCHG), uses the values in SAVEVALUES 150,151, 155, and 156. A one in SAVEVALUE 150 flags the section of code in GECCHG necessary to provide a change in link status. A one in SAVEVALUE 151 flags the future execution of MESGEN to check for "BAD NEWS". A zero in SAVEVALUE 155 flags the execution of code in GECCHG to drop the link whose value is in SAVEVALUE 156 (1 => Gentile's first link). When GECCHG (Figure 29), is activated, statement 4 passes control to statement 5. Indexes into Gentile's LD table (GEN1 and GEN2), are set up with GEN1 taking on Gentile's ID number and GEN2 taking on Pt. Detrick's ID number. At the encircled "A" of Figure 29, execution of the instruction determines whether the link change involves dropping the link from or adding it back to the Gentile node. If the link is to be dropped, (SAVE-VALUE 155 = 0), control is passed to statement 10, other-

••	STH EX	ETH EXAMPLE - DRJP 15T LINK AT GENTILE AND THE CORRESPONDING LEMK AT FT. DETRICK.
Section 6 :		
Part 1	GENERATE PAI OPITY	25000,,25002,1,,, F GENERATE 1 PACKET 25 SECS INTO SIMULATION.
	ASSIST	2,2 SEI PARAMETER 2 WITH THE PACKET PRIORITY.
	SPLIT	1, SECPR SEND COPY FOR 2ND NODE PROCESSING.
	SAVEVALUE	15-0-15-XL SET FLAG FOR LINK LOSS.
	SAVEVALUE	191919AL SCI FLAS FOR AND PROCESSING. 1959,63XL FLAG 10 OKOP LINK.
	SAVEVALUE	
,		GECUTO, TIPEST STREETS OF THE TIME. GENAL GO SEE IS STAT. MSG. IS NECESSARY.
SE	SECPR SAVEVALUE	
	SAVEVALUE	
	S 4 V = V AL 13 E	1409U9AL TERM TO UPOF LIME.
	HAL PC	DECCHES PLANS BY PERSON OF THE STATE OF THE
	TANSFER	DETHI GO SEE IF STAT. HSG. IS NECCESSARY.
•		
• •		- REESTAPLISH 1ST LINK AT GENTILE AND THE CORRESPONDING
•		
Part 2	GENERATE	46660, 46882, 1,,, F GEN. 1 PACKET 46 SECUNDS INTO SIMULATION.
	P.RIORITY	2 GIVE IT PRIORITY CLASSIFICATION.
	ASSIGN	2,2 SET PARAMETER 2 WITH PRIGALTY.
•	ASSIGN	1
	6.2L IT	
	SAVEVALUE	SET FLAG FOR LINK ADD.
	SAVEVALUE	TOTAL AND THE TOTAL TOTAL TOTAL TRUCKSOTINGS 155.1.X. FLAG 10 ADD 11 AV BACK.
	HELPC	GECCHG, PL, PZ, PJ, PF, PF, PC, DD LINK.
•		GENH1 GO SEE IF STAT. MSG. IS NECCESSARY.
SE	SECP1 SAVEVALUE	14-0-11-XL SET FLAG FOR LINK AUD.
	SAVEVALUE	1+1, C, XL SET FLAG FOR GOUD NEWS PROCESSING.
	SAVEVALUE HELOC	14co15XL FLAG TO ADD LINK RACK.
	TRANSFER	DETMI GO SEE IF STATE ASG. IS NECCESSARY.
	•	

Fig 28. Code for Loss of Gentile - Ft. Detrick Link

```
INTEGER PARTYA (b), ALO(2,1), VAR(1), FUN (2,1), BVA (1), CHA (3,1)

INTEGER FACE, 1), 6RO(1), HSA (1), LOG(1), RUE(4,1), STU (7,1), TAB (9,1)

INTEGER FWA (1), FSA (1), HYA (1), FNA (1), LAG (1), GSA (1)

KEAL SAVVGC(1)

BU HORLYGETATL/GELD (3,6), SEP (9), INF1, GENN, GENC (32), BEROUT (4),

GEN (4,1), GFNOP (b), GELL (5T (32), GESCLF, GENUR, GLS, GEE, GLSROT (8),

GELL (4; 63, 6G BUF (1), GEPUT (4), GENF [1), GEPARM(6), GEBUP (5),

TATE GFF GSS, GEND, GEP, SEU (4, GENUP, GFL) ST, GEBUF F, GEBUF (6, GEPARM,

GGLS, ST, 3, RT STUS, BEZOVE, SELL 11, GELZ, GESTAT
                                                            CO-IN-CHANGE UPDATES THE 42 TABLE TO REFLECT IF A LINK HAS COMECTIVITY CONTROL OF SOME DDW4. THE APPROPAIATE LINK CONNECTIVITY SYTY FOR (N14.N2) IS UPDATED TO DENUTE THE NEW CONNECTIVITY STATUS OF THAT LINK, MESSEN AND UPDATE (WHICH CALL MINHOP AND RTAPLE) SHOULD BE CALLED TO REFLECT THIS NEW LINK CONNECTIVITY STATUS.
subkoutine recche(par4va, blo, var, fun, bya, cha, fac, gko, hsa, log,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                6EJUP(INT(SAVVGE(156))) # 1
6ELU(5FN1,6FK2) = 6ESTAT # ABS(6ELD(GEN1,6ENZ))
I = GCP(5EN1) - 1
I = I + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CONN_CHANGE Subroutine for Gentile
                           FOUR, STOUT AND THAS TURE LAR DEBOL MA GREAT SAVOED
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               IF (THI(SAVVGE(1251) .GT. 8) GO TO 110
GELINS(INT(SAVVGE(156)) * 2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       1F (12) ($4VGE(15U)) . NE. 0) 60 TO 60 TO 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 GESTAT # -1
GESUPCIAT (SAVVGE(150)) # 1010
GO TO 21
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    GENS = 1498(GENC(1))

IF (GFN2 -NT- GEN3) G) TO 25
GENC(1) = GESTAT + GENS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           GE 11 = GESELF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      GE 37 47 = 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           EXI TREM
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      113
1800
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              F1g 29.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   300
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          . a
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                                                    4444444
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        0
```

wise control is passed to statement 15. At statement 10 GESTAT is set to a -1 (used shortly to set the appropriate entry in Gentile's LD matrix and the link number in Gentile's NC array to negative values). XXBUP (GEBUP for Gentile) is an array denoting the current status of the Gentile links. A one in the array indicates the link is up and a 1000 indicates the link is down. Since SAVEVALUE 156's value is a 1, GEBUP(1) is set to 1000 to indicate the loss of the link. (The GEBUP array is used in MESGEN to compare it against the previous status of the links contained in the XXSTUS array (GESTUS for Gentile)). Control is then passed to statement 20 where the value of the LD matrix indexed by GEN1 and GEN2 is made negative (used later in GEINID and GECOMD to recalculate the D matrix for Gentile). Index I value is calculated to equal the value of GEN2 and the corresponding value of Gentile's array is made negative. Control is then returned to the GPSS simulation program. In order to compensate for this new condition, the packet is transferred to a portion of code in Section 2 (GENM1) used to handle the processing of Gentile's version of MESGEN and Gentile's association entries into UPDATE, INITIAL_D, COMPUTE_D, and RTABLE. duplicate copy of the packet sent to SECPR (encircled "A" on Figure 28), receives similar processing for the Ft. Detrick node as discussed above for the Gentile node.

After forty-six seconds of simulation elapses, the link between Gentile and Ft. Detrick is brought back up into operational status by the execution of the code in Part 2 of Figure 28. SAVEVALUES are changed to flag the execution of code in GECCHG and DECCHG to reverse their previous actions and reestablish the link between Gentile and Ft. Detrick.

CONN_CHANGE is entered to bring the link back up, MESGEN builds new status information which is sent locally and to the other nodes. UPDATE makes the appropriate changes to the LD matrix, INITIALIZE_D reinitializes the D matrix and associated arrays. COMPUTE_D recomputes the new D matrix and RTABLE recomputes the link routing arrays SROUTE and ROUTE. The processing necessary to drop a link versus what is necessary to drop a trunk is more complicated because a major change in network connectivity is occurring. New status information will be generated when MESGEN is entered later or thus everything must be set up for other subroutines to simulate the condition correctly.

Node Loss Simulation. The code necessary to accomplish the removal of a node from the network is more complicated than that of either of the two previous examples. Each of the nodes connected to the non-operational node must remove their respective link to the down node from operational status and throw away the packets whose destination is the downed node. In this simulation program, even though the last node is disconnected from the rest of the network it still generates packets and processes them as if it were operational. It was easier to incorporate this change than remove the node's code completely when it goes down and replace the code when the node comes back up again. When the

node's PAKROUTE subroutine is activated, instead of putting the appropriate trunk number into the related FULLWORD SAVE-VALUE an integer number is placed in the related FULLWORD SAVEVALUE which, when control is returned to the main simulation program, causes the packet to be sent to a TERMINATE block for removal from the system.

Similar changes were required in each of the other node's PAKROUTE subroutines. If the packet's destination is the downed node, the appropriate integer number is placed into the related FULLWORD SAVEVALUE which will result in the packets eventual removal from the system. Figure 30 shows Section 6's code required to simulate the loss and reestablishment of the Ft. Detrick node. As in the previous two examples there are two parts to the code. The nodes connected to Ft. Detrick (Albany, Andrews, Hancock, Gentile, and Tinker) each have their own section of code in Part 1 to simulate the loss of Ft. Detrick. In each node's code, their respective SAVEVALUEs are set up to drop their link to Ft. Detrick and CONN_CHANGE is executed at each node. Ft. Detrick's code (starting at the label SECPD) loads its SAVEVALUE with special flags. SAVEVALUE 141 is loaded with the normal value of 1 to denote "BAD NEWS" processing in MESGEN. The other SAVE-VALUEs are loaded with dummy values which, in effect, causes no change in the status of any of its links in DECCHG. key SAVEVALUE is 146. It is loaded with a value of 1. Its purpose will be explained shortly.

When CONN_CHANGE has been executed at each connected

16TH EXAMPLE - DROP NODE FT. DETRICK FROM THE NETWORK.

Section 1	•			
		GENERATE	25000,,25302,1	25030,,25302,1,,,F GEN. 1 PACKET 23 SECONDS INTO SIMULATION.
Part	-	P < 1 00 I TY	2	GIVE IT PRIDRITY CLASSIFICATION.
		ASSIGN	2,2	SET PARAMETER 2 WITH THE PACKET PRIORITY.
		ASSIGN	, M	SET PAPA, 3 WITH THE SPECIAL STAT, PKT, LENGTH
		SPL IT	1, SECPD	SEND COPY FUR FT. DETAICK PROCESSING.
		SAVEVALUE	121.1.XL	SET FLAG FOR LINK CHANGE.
		SAVEVALUE	122,1, XL	SET FLAG FOR BAD NEWS PROCESSING.
		SAVEVALUE	126, 0, XL	FLAG TO DROP LINK.
		SAVEVALUE	127,2, XL	DFOP LINK 2 AT ALAANY.
		HELPC	ALCCHG, P1, P2, P3, P4, P5, Pt	3.P4.P5.Pt GO DROP LINK.
		THAMSFER	, ALSM1	
	SECPD	SPL II	1, SECPA	SEND COPY FOR ANDREWS PROCESSING.
		SAVEVALUE	140,1,XL	SFT FLAG FOR LINK CHANGE.
		SAVEVAL JE	1+1,1,XL	SET FLAG FOR BAD NEWS PROCESSING.
		SAVEVALUE	140,1, XL	SET FLAG FOR FT. DETRICK'S LOSS.
		SAVEVALUE	147,1, XL	SEI DUMMY FLAG FOR ALBANY'S LINK.
		HEL PF	DECCHG, P1, P2, P3, P4, P5, PA	3,Pt,Pt,PA GO ORUP THE NODE.
		T 44 No FER	, DET41	GO SEE IF STAT. MSG. IS NECESSARY.
	SECPA		1, SFCPH	SEND COPY FOR HANCOCK PROCESSING.
		SAVEVALUE	130,1,XL	SET FLAG FOR LINK CHANGE.
		SAVEVALUE	131,1,XL	SET FLAG FOR BAD NEWS PROCESSING.
		SAVEVALUS	135,0,XL	FLAG TO DKOP LINK.
		SAVEVALIIE	130,2,XL	DROP LINK 2 AT ANDREWS.
		HELPC	ANCOHG, P1, P2, P	ANCCHG, P1, P2, P3, P4, P5, P6 G0 DROP LIMK.
		TRANSFER	2 ANDM1	GO SEE IF STAT. MSG. IS NECESSARY.
	SECPH		1,5 ECPG	SEND COPY FOR GENTILE PROCESSING.
		SAVEVAL'JE	10,1,XL	SET FLAG FOR LINK CHANGE.
		SAVEVALUE	161,1,XL -	SET FLAG FOR RAD NEHS PROCESSING.
		SAVEVAL'JE	164,0,XL	FLAG TO DRUP LINK.
		SAVEVALUE	105,2,XL	
		HELPC	HACCHG, P1, P2, P3, P4, P5, PE	3,Pi,FF,PE GO DRUP LINK.
		TAMBRES	, HANM1	GO SEE TE STAT, MSG. IS NECESSARY.
	SECPG	SPLIT	1, SECPT	SEND COPY FOR TANKER PRUCESSING.
		SAVEVALUE	150,1,XL	SET FLAG FOR LINK CHANGE.
		SAVEVALUE	1>1,11,XL	SEI FLAG FOR RAD NEWS PROCESSING.
		SAVEVALUE	105,0, XL	FLAG 10 DROP LINK.
		SAVEVALUE	155,1,XL	DROP LIMK 1 AT GENTILE.
		HELPC	GECCHG, P1, P2, P	GECCHG, P1, P2, P3, P4, P5, P1, GO DKOP LINK.
		TAANSFER	, GENM1	GO SEE IF STAT. MSG. IS NECESSARY.
	SECPT		190,1, XL	SET FLAG FOR LINK CHANGE.
		SAVEVALUE	191,1, XL	SEL FLAG FOR BAD NEWS PROCESSING.
200	Dec.) q (19to to XL	
r18 30.	exambre	e or code	IOL LOSS	and keturn of a wode

NECESSARY.
197,3,XL DROP LINK 3 AT TINKER. TICCHG,P1,P2,P3,P4,P5,P6 GO DRUP LINK. ,TINH1 GO SEE IF STAT. HSG. IS NECESSARY.
DROP LINK P3,P4,P5,P6 G0 SEE IF
197,3,XL TICCHG,P1,P2 ,TINH1
SAVEVALUE HELPC: T-ANSFER

RESTORE THE FT. JETRICK NODE TO OPERATIONAL CAPABILITY.

Part 2	*~	2 TA 7 E 8 E 8	46300.46002.1.	\$530045082.1F GEN. 1 PACKET 46 SECONDS INTO SIMULATION.
		PALOSITY	2	GIVE IT PRIORITY CLASSIFICATION.
		ASSIGN	2,2	SET PARAMETER 2 MITH PRIORITY.
		ASSIGN	3,3	SEI PAPA. 3 HITH SPECIAL STAT. 456. LENGTH.
		SPL II	1, SECP1	SENU COPY FOR FT.DETRICK PROCESSING.
		SAVEVALUE	121,1, XL	SET FLAG FOR LINK CHANGE.
		SAVEVALUE		SET FLAG FOR GOOD NEWS PROCESSING.
		SAVEVALUE	126,1,XL ,	FLAG TO ADD LIMK BACK.
		HEL PC	ALCCHG, P1, P2, P3, P4, P5, Pu	
		TANSFER	, ALGH1	GG SEE IF STAT. MSG. 18 NECESSARY.
	SEC P1	SPLIT	1, SECP2	SERD COPY FOR ANDREHS! PROCESSING.
		SAVEVALUE	140,1,XL	SET FLAG FOR LINK CHANGE.
		SAVEVALUE	141,0 XL	SET FLAG FOR GUOD NEWS PRUCESSING.
		SAVEVALUE		RESET FLAG FOR DETRICK'S RETURN.
		TRANSFER	, DET M1	GO SEE IF STAT, MSG, IS NECESSARY.
	SECP2	SPL IT	1, SECP3	SEND COPY FUR HANGOCK PROCESSING.
		SAVEVALUE	130,1,XL	SET FLAG FOR LINK CHANGE.
		SAVEVALUE		SET FLAG FOR GOUD MIMS PROCESSING.
		SAVEVALUE	135,1,XL	FLAG TO ADD LINK BACK.
		HELPS	ANCCHG, P1, P2, P3,	NCCHG, P1, P2, P3, P4, F5, Pt GU ADD LTNK.
		1 RANS FER	PANDMI	GO SEE IF STAT. HSG. IS NECESSARY.
	SEC P3	SPLII	1, StOP4	SENU COPY FOR GENTILE PROCESSING.
		SAVEVALUE	100,1,XL	100,1,XL SET FLAG FOR LINK CHANGE.
		SAVEVAL'1E	161,0,XL	SET FLAG FOR GOOD NEWS PROCESSING.
		SAVEVALUE	10+,1,XL	FLAG TO ADD LINK BACK.
		HEL PC	HACCHG, P1, P2, P3,	PS, Pi, Pt. GU ADD LINK.
			, HARMI	GO SEE IF STAI. MSG. IS NECESSARY.
	SEC P4			SEND COPY FOR TINKER PROCESSING.
		SAVEVALUE	150,1,XL	SET FLAG FOR LINK CHANGE.
		SAVEVALUE		SET FLAG FOR GOOD NEWS PROCESSING.
		SAVEVALUE	150,19 XL	FLAG TO ADD LINK BACK.
		HELPC	GECCHG, P1, P2, P3, P4, P5, Pc	PL, P5, Pc 60 ADD LINK.
			, GENM1	GO SEE IF STAT, MSG. IS NECESSARY.
	SECPS	SAVEVALUE	190919XL	SET FLAG FOR LINK CHANGE.
Fig 30.		(CONT.D)		

SAVEVALUE 191,0,XL SET FLAG FOR GOOD NEWS PROCESSING. SAVEVALUE 196,1,XL FLAG TO ADD LINK BACK. HELPC TICCHG,P1,P2,P3,P4,P5,P5 GO ADD LINK. TRANSFER ,TINM1 GO SEE IF STAT. MSG. IS NECESSARY.

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node and at Ft. Detrick, the individual status are transferred to portions of code in Section 2 to activate the other subroutines necessary to complete the generation of new status information, update and recalculate the node's database and to broadcast each node's new status information to the rest of the network. After 46 seconds of simulation time, the GENERATE block in Part 2, generates 1 packet. The packet and its copies (created from the SPLIT blocks) process through their respective node's reseting the SAVEVALUES which are needed to simulate Ft. Detrick coming back up. CONN_CHANGE is executed at each node except Ft. Detrick. Due to the dummy values in Ft. Detrick's SAVEVALUES, if DECCHG were executed, Ft. Detrick's link to Albany would be simulated as being down.

After return from CONN_CHANGE, the various status packets are sent to portions of code in Section 2 for further processing necessary to recalculate and update their respective node's database.

The only program changes to the algorithm were to each node's version of PAKROUTE. The same four changes were required at every node's PAKROUTE subroutine except Ft. Detrick's which required three changes. Figure 31 shows the resulting PAKROUTE subroutine for Albany. The encircled "A" shows the four instruction changes. The first instruction tests to see if Ft. Detrick is down (SAVEVALUE 146 = 1). If the node is not down, control is passed to statement 3 and normal processing occurs. If Ft. Detrick is down, the next instruction tests to see if the destination of this packet is Ft. Detrick.

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COJMON/ALTAPL/ALLO(0,3), ALP (5), INFI, ALNINALNO (12), ALRUUT(8), ALD (9,8), ALVOP(6), ALLIST(72), COLF, ALRUCH, ALS, ALS 20I (4), ALLIST(72), COLF, ALRUCH, ALS, ALS 20I (4), ALLIST(72), COLF, ALRUCH, ALRUCH (0), ALBUP (4), ALZONE, ALLIST(73), ALRUCH, ARROTH (0), ALBUP (4), ALZONE, ALLIST(73), ALRUCH, ARROTH (0), ALBUP (4), ALZONE, ALLIST(73), ALRUCH, ARROTH (0), ALZONE, ALZONE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  INTEGER O APPYA (5) - SLO(2-1) - VALLL) - FINL(2-1) - AVALL) - CHA (5)-1) - INTEGER FAC (5-1) - CHA (3)-1) - TAR(9-1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                               (ALPARH) THAT BELDNG TO THE CONPENT PACKET. THE PAKAMETERS
And Restructively:
                                                                                                                                                               PAKKOUTE LOOKS AT THE OUGUE LENGTHS OF THE INDIVIDUAL TRUNKS HAKING UP THE LINK AS SELECTED BY SNOUTE OR RUUDE(SOURCE NODE OR TANDEM NODE) AND SELECTS THE TRUNK MITH THE LEAST NUMBER OF PACKETS CURVED TO BE THE TRUNK TO QUEUE THE CUPRENT PACKET ON, PASSED TO PAKKOUTE ARE THE PARAMETERS
SUBROUTINE ALPKRT (PARHVA, BLO, VAR, FUN, BVA, CHA, FAC, GRO, HSA, LOG, +QUE, STO, TAB, FMA, FSA, H4A, 34A, LMA, BSA, SAVVAL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     INTEGE GAS ALS, ALGO 11 NO ALMED 12 LESTED 1 ALBUD 1 AL 70NE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       *ALSELF;»LLML: »ALE,ALEOJT;ALOCT;»ALLTES;ALOCFF;ALOCFT;ALPAKY;
*ALTI;ALT?AISTUS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 PARAMETR 11 DESTENSTIUL NOUE IN OF THE PAUKET.

21 FACKET PALDAINY 1-40N PRIO, 2-PKIUKITY

31 PAUKET LENGTH 1-5MOLT , 2-LONG

41 SOURE 100L 100 OF THE PACKET.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               THUNK IT A SE EERMINGETE, UNDELIVERABLE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              INTEGER F ** 11) F 5 4 (1), H41(1), C46(1), CH6(1), C 4 (1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    INURE IN # OF LUCAL PELIVENY.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 SAVEVALUE (1) WILL CONTAIN THE TONK TO B
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              IF (IN)(3AVVAL(146)) .NE. 1) 63 TO
IF (IDSF4 .LE. 3) 63 TO 3
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       TO TRABBALL THE BRUKET CH.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        S
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DO 2 I=1,7
AL 3UF! (I) = INT(SAVVAL(I))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               DU 1 IAL=1,0
AL>4?!(IAL) x PA=!!VH([AL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              *ALT1, ALT2, 41 S TUS (+)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CODERTED TO COLUMN
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          REAL SAVYAL (1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      FS4(1) = 9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         KEAL TITE
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                                                                                                                       00000000000000000
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Fig 31. PAKROUTE for Albany

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FSA(1) = 0 + 2

GC TO 101)

IF (ALGU=T(J+1) GT. ALGUFT(J+2)) &D. TO 45

FSA(1) = 0 + 1

FSA(1) = 0 + 2

FSA(1) = 1 + 2

KETURN

END
                                                                                                                                                             60 TO 14)3

1F (I .E.Q. ?) GO TO 3)

1F (ALTUFT(J) .LE. ALBUFT(J+1)) GO TO 25

FSA(1) = J + 1

GO TO 1910
                                                                                                                                                                                                                                        60 TO 101.

IF (ALBUF10) .GT. ALBUFT(J+1) GO TO 40

IF (ALBUFT(J) .GT. ALBUFT(J+2)) GO TO 35:

FSA(1) = J
60 TO 1010
IF (INSAG .FQ. ALSELF) GO TO 10
K = ALPOUT(IDSTN)
                                              K # ALSROT(IDSTN)

1F (K .NE. C) 60 TO 15

FSA(1) # 9
                                                                                                                                   IF (I .MT. 1) GQ TO 2)
FSA(1) = J
                                                                                                          I = ALLINS(F)
J = 11 PFIC(K)
                                                                                                                                                                                                                                FSA(1) = J
                                                                                                                                                                                                                                                                                                                                                                                 45
1636
                                                                                                                                                                                                                                                                                                             ;;
                                                      94
                                                                                                                                                                                                                               $
                                                                                                                                                                                                                                                         30
                                                                                                                                                                                                                                                                                                                                     0 4
                                                                                                            5
                                                                                                                                                                           2
```

Fig 31. (CONT'D)

(packet parameter 1 = 3). If the destination is not

Ft. Detrick, control is passed to statement 3 for normal

processing. If Ft. Detrick is the destination, FULLWORD

SAVEVALUE 1 is set to 9. Control is then passed to state
ment 1000 for return to the GPSS program. Back in the

simulation program the value in FULLWORD SAVEVALUE 1 is moved

into packet parameter 5 and the packet is transferred to

UNDEL for removal from the network.

Figure 32 shows the resultant code for Ft. Detrick. The code shown by the encircled "A" are the three changes added to the PAKROUTE subroutine at Ft. Detrick. If the node is not down, control is passed to statement 3 for normal processing. If the node is down, it can't transmit any packets, thus 13 is stored in FULLWORD SAVEVALUE 3. Control is passed to statement 1000 for return to the main simulation program. Upon return, the value in FULLWORD SAVEVALUE 3 is moved in packet parameter 5. The value of FULLWORD SAVEVALUE 3 (14) is used by FUNCTION ROUT3 to send the packet to UNDE3 for termination and removal from the system.

The following chapter contains an analysis of the algorithm's ability to adapt to traffic fluctuations while network topology changes are occurring. The chapter also contains a comparison summary of the packet delay results obtained by the simulation exercise and the packet delay requirements as set forth in DCA's Performance Specifications for the AUTODIN II network. The summary includes specific examples of topological changes and traffic fluctuation

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INTEGFR FAC(5,1), bKU(1), H6A(1), LUG(1), DUL(4,1), STU(7,1), TAB(9,1)
INTEGEP FMA(1), FSA(1), FMA(1), BMA(1), LPA(1), NSA(1)
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                                                                            PAKKOUTE LOOKS AT THE DUEJE LENGTHS OF THE INDIVIDUAL TRUNKS HAKING HP THE LINK AS SELECTED BY SKOUTE OR ROUTE(SOURCE HUDE OR TANDEM HOJF) AND SELECTS THE TRUNK WITH THE LEAST NIMMER OF PACKETS DUEJUED TO RE THE TRUNK TO DUEJE THE CHREAT PACKET ON, PASSED TO PAKROUTE ARE THE PARAMETERS
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TRUNK ID = 14, TERMINATE, UNDELIVERAGLE.
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2: PACKET PAIDAITY 1-NON PRIO, 2-PRIURITY

3: PACKET LENGTH 1-SHOKT , 2-LUNG

4: SOURCE 40DE 10 OF THE PACKET.

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THE PACKET ON.
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PAKROUTE for Ft. Detrick

Fig 32.

3

F1g 32. (CONT'D)

levels not satisfying the Performance Specifications based on statistical Hypothesis tests and confidence intervals, and a short section on the disturbance periods (the time between the traffic spike and the return of the network to the system mean delay). The paper concludes with reccommendations on possible network reconfiguration changes and ideas on further simulation exercises.

VIII Simulation Results and Analysis

It should first be stated that the development of the simulation model, and thus its packet delay results evolved from the author's interpretation and implementation of DCA's preliminary design requirements package which included traffic volume figures, internodal packet exchanges, and the network Base Routing matrix. Since the actual algorithm code was not available, the author's implementation of the algorithm in Fortran is also susceptible to interpretation. It is the author's opinion that given the model used and the methodology of its development, the conclusions (in Chapter IX), statements, and analysis of the delay results in this report are factual.

Algorithm Adaptability

webster's New Collegiate Dictionary defines adaptation as "the act or process taken to adjust to environmental conditions". The ability to adapt to these changing environmental conditions (traffic volume fluctuations and network topology) is a measure of the hierarchical routing algorithm's performance. If the algorithm causes undue excessive packet delay in the process of adapting to and compensating for changing environmental conditions, it is said to be not well-behaved. Without any precedence to go by in defining "undue, excessive packet delay", the author appends the following values to the definition; for any mean packet delay from the simulation equal to or greater

than 570 msec for short packets and 795 msec for long packets, the algorithm is said to be not well-behaved. Another measure would be 2025 msec for the maximum packet delay of short packets and 2250 msec for the maximum packet delay of long packets. These values (defined by the author) are one and one half times the packet delay requirements given in Figure 25, Chapter VI.

The author developed an additional performance criterion as a measure to determine another behavioral pattern of the algorithm. The "disturbance period" is defined to be the time it takes for the network to return to within a 95% Confidence Interval of the system mean packet delay after the occurrence of a traffic spike. The system mean packet delay is the delay value in parenthesis at the 30 second time frame on each graph. Also for identification purposes, the delay values in parentheses during disturbance periods, in graphs of Appendices F through I, are the maximum packet delays incurred from packets terminating (locally delivered) within the previous one second time interval.

Having defined two performance characteristics to determine the adaptability of the routing algorithm, four sample cases are discussed with respect to the algorithm's ability to adapt to the changing environmental conditions.

Selected Results Explained

The four cases being discussed are (1) the fully operational network with the algorithm versus the baseline program, (2) an example from the trunk loss program runs, (3) an example from the link loss program runs, and (4) an example from the node loss program runs.

Fully Operational Network Versus Baseline. In this section, the graphs of the baseline results (Figures 22, 23 and 24 of Chapter VI) are compared against the graphs of the fully operational network in Appendix F (Figures F-1, F-2, and F-3).

In comparing the graphs of the system delay (all packets), Figures 22 and F-1, the baseline program takes nine seconds to return to equilibrium whereas the algorithm version takes only five seconds. These disturbance periods mean the algorithm can react to traffic fluctuations in intensity faster than the static routing methodology of the baseline program. Also shown in these graphs is the maximum delay times experienced by any packet during the disturbance The maximum delay a packet experiences in the algorithm version (1850 msec) occurs two seconds after the 90% spike. In the baseline program, the maximum delay (2830 msec) occurs three seconds after the 90% spike. The mean delays are higher in the algorithm version than in the baseline but this is due to additional load on the system because of the system status packets being generated and broadcast throughout the network. With the addition of the algorithm, the additional status packets add 6% to the traffic volume in the network over and above what the baseline was processing. Also as a matter of interest, is the fact that all the packets

in this additional 6% are priority packets which in effect delay the vast majority of the other packets in the network which are non-priority. But even with this additional traffic load, the algorithm minimized the affect of the traffic spike, lowered maximum delay times, and reacted to the traffic fluctuation better than the baseline program.

Figures 23 and F-2 are related graphs showing the system delay for non-priority - short packets. The same conclusions on the algorithm performance can be drawn if the two graphs are compared to each other. The disturbance period is shorter with the algorithm (5 seconds versus 7 seconds), maximum delay is lower (1850 msec versus 2710 msec), and the mean delays during the disturbance period is lower for the baseline. An interesting characteristic of the algorithm is the apparent immediate reaction to the traffic spike. One second after the spike, the maximum mean delay is reached, but in the baseline the maximum mean delay occurs two seconds after the spike.

Figures 24 and F-3 show the results of the two simulation versions for the system delay of non-priority - long packets. The affect of the algorithm on the disturbance period is pronounced in comparing the delay trends at the 90% saturation level (4 seconds in the algorithm version and 9 seconds in the baseline).

The data obtained for the short and long priority packets cannot really be compared. As stated in Chapter VI, there are not enough user priority packets generated for qualitative or quantitative analysis. The data does show though, (in Tables IX and X of Chapter VI, and Tables F-1 and F-II) that the delays experienced by the priority packets did not exceed the mean or maximum delay constraints as specified in the DCA Performance Specifications (Figure 25, Chapter VI).

Simulated Topology Degradations. One of the characteristics of an efficient routing algorithm is its ability to recognize and respond in a prompt, orderly manner to network topology changes. These changes could consist of losses of trunks, complete links, or even nodes in the network. In this section of the chapter, the simulation of topological changes are made selectively, choosing one of the network's trunks, links, or nodes, and dropping it from the network. While the facility is non-operational, a traffic spike occurs, requiring the algorithm not only to compensate for the lost facility, but also to contend with the spiked increase in traffic volume. The selection of which trunks, links, and nodes to drop is made based on dropping a trunk in the most heavily utilized link, dropping that link itself, and dropping the most vital tandem nodes of the network. In order to have something to measure in the disturbance periods of the topological change simulation runs, the disturbance periods of the fully connected network simulation runs (Figures F-1 through F-3) are used as control samples. For the graphs showing packet delays for all packets (Figure F-1), the disturbance period is 5 seconds (from time frame 31 to time frame 36). For the graphs showing packet delays for short

packets (Figure F-2), the disturbance period is also five seconds. For the graphs showing packet delays for long packets (Figure F-3), the disturbance period is four seconds (from time frame 31 to time frame 35).

Sample Trunk Loss. The trunks dropped are the trunks in the links connecting Albany - Ft. Detrick, Ft. Detrick - Gentile, Andrews - Tinker, Ft. Detrick - Tinker, and Gentile - Tinker. Each of the five examples involves running the program four times, once per saturation spike. In the AUTODIN II network, trunks are full duplex (two-way) transmission lines, that is, traffic is both sent and received on the same trunk. However, in the simulation, two one-way trunks are required to effect the simulation of one full duplex trunk in the proposed network.

Results from simulation runs involving the losses of trunks are given in Appendix G. Each example of the graphical and tabular results is preceded by a page informing the reader which set of trunks is dropped for that example.

For the trunk loss example, the simulation runs simulating the loss of a trunk in the link between Gentile and Tinker (Figures G-13 through G-15), is selected. Although it is one of the worst-case examples for the set of trunk loss runs, the use of it in the ensuing discussion merits investigation. Even with the loss of the trunk, the disturbance periods for both the all-packet graph (Figure G-13), and the short packet graph (Figure G-14), equals the matching graphs of the control sample. The disturbance period for

the long packet graph (Figure G-15) is 5 seconds which is only one second longer than that of the long packet control sample. Typically, this means even with the additional burden of a lost primary trunk, the algorithm enables the network to withstand a large traffic spike (90% saturation worst-case) and still return to within a 95% Confidence Interval of the mean system delay within five seconds of the time of the spike. If another traffic spike occurs within five seconds of the first spike, the network would undergo additional stress and could quite possibly become not wellbehaved. Since the network had already attained mean delay equilibrium by the time the trunk came back up, its addition to the network did very little to lower the system mean packet delay. An interesting aspect of the delay results during the disturbance period shows that the mean and maximum packet delays for the 60, 70, and 80 percent saturation runs (Figures G-13 through G-15) are less than those of the control sample (Figures F-1 through F-3). This could imply that the algorithm calculates better paths for packets to take while under moderate stress. Although the algorithm is well-behaved in this trunk loss sample, the mean and maximum packet delays for 90% exceeds the DCA delay requirements.

Sample Link Loss. The links simulated going down are the links connecting Albany - Ft. Detrick, Albany - Andrews, Gentile - Ft. Detrick, Andrews - Hancock, Andrews - Ft. Detrick, Andrews - Tinker, Ft. Detrick - Tinker, and Gentile - Tinker. Appendix H contains the graphical and tab-

ular results of the eight examples of link losses. They are arranged in a similar fashion as those given in Appendix G.

For an example of the link loss sample runs (Figures H-13 through H-15), the Andrews - Tinker link is chosen for discussion. The impairment to the network as a result of the lost link is evident in the graphs. In both the allpacket delay and the short packet delay graphs (Figures H-13 and H-14 respectively), the disturbance period for the 60, 70, and 80 percent saturation runs is seven seconds (from time frame 31 to time frame 38), but for the 90% run it is nine seconds. In the long packet delay graph (Figure H-15), the disturbance period is six seconds for the 60, 70, and 80 percent runs and nine seconds for the 90 percent run. longer recovery times indicate a threat to the network's stability as the result of the loss of a primary link. Although well-behaved in the 60, 70, and 80 percent ranges, both the mean and maximum packet delays exceed those of a well-behaved algorithm for the 90 percent saturation level. When the link comes back up (time frame 42), its result on the network causes a slight smoothing effect on the packet delays.

Sample Node Loss. The nodes selected for removal from the network are Ft. Detrick, Gentile, and Tinker. Appendix I, in the same format as Appendices G and H, contain the graphical and tabular delay results for the node loss examples.

The removal of Ft. Detrick from the network is the exam-

ple from the set of node losses (Figures I-1 through I-3, Appendix I), to be discussed. The example shows the disastrous effects the removal of a primary node has on the network. On all three graphs the disturbance period is twelve seconds (one second after the node comes back up at time frame 42). The occurrence of any moderate traffic spike within the twelve second time period would most likely result in massive packet delays and a strong possibility of unstable and unbounded output trunk queues at the other network nodes. The algorithm is not well-behaved in any of the packet delay graphs, in fact, packets incur delays of up to four and a half seconds in the 90 percent run.

Due to the limited number of priority packets generated (1% of all packets), the tabular results of the priority packet delays in each set of examples discussed above does not provide conclusive evidence as to the performance of the algorithm for priority packets. Inspection of the results does show three things however; all of the mean and maximum delay values for short packets are within DCA requirements, about one and one half percent of the long packet mean delays exceed the DCA requirement of 330 msec, but none exceed the maximum delay requirement of 730 msec, and the topological changes seems to have no effect on the mean and maximum packet delays for priority packets.

Summary Tables

In order to consolidate and present all of the infor-

mation in Appendices F through I, in a more visible manner, this last section presents four tables to the reader. The thrusts of the four tables are to show the adaptability of the hierarchical routing algorithm through the two performance criteria defined previously and to back up the statistical results of the simulation runs. The statistical calculations provide 95% Confidence Intervals and One-Tail Null Hypothesis tests on the data contained in Appendices F through I on which the four tables are based.

Using a 95% Confidence Interval to determine when the network returned to equilibrium after the traffic intensity spike, Table XI gives a summary of the various disturbance periods (in seconds) for each simulation run conducted.

The "All - Packets" graphs of each set of runs were used to generate Table XI.

Tables XII and XIII are produced using the Null Hypothesis Test and testing for $\mu > \mu_0$ at $\alpha = .05$ for non-priority short packets and non-priority long packets respectively. The Null Hypothesis was $\mu = \mu_0$ ($\mu_0 = 380$ msec for short packets, $\mu_0 = 530$ msec for long packets), and the Alternate Hypothesis was $\mu > \mu_0$. The tests were conducted either assuming large sample populations with a normal distribution or known standard deviations from the output of each computer simulation run. The "dashed" entries correspond to where the Null Hypothesis was accepted and the "OVER" entries correspond to the rejection of the Null Hypothesis in favor of the Alternate Hypothesis.

TABLE XI

Disturbance Period Summary

20%

(entries are in seconds) Network Configuration		Traffic S	Traffic Spike Level
	60% 80%	<u>20%</u>	80%
Fully Operational	6	٣	٧.
Trunk Loss			
Albany - Ft. Detrick	у.	#	'n
Andrews - Tinker	х	4	ω
Ft. Detrick - Tinker	~	٣	٧.
Ft. Detrick - Gentile	ν,	v	'n
Gentile - Tinker	Ň	ν.	٣
Link Loss			
Albany - Ft. Detrick	⇒	9	Φ
Albany - Andrews	4	#	٧,
Andrews - Hancock	٣	7	ν.
Andrews - Ft. Detrick	~	٧	10
Andrews - Tinker	٣	2	~
Ft. Detrick - Gentile	2	ν,	۷
Pt. Detrick - Tinker	٣	4	m
Gentile - Tinker	9	٣	9

TABLE XI (CONT'D)

(entries are in seconds) Network Configuration Node Loss Ft. Detrick Gentile
--

TABLE XII

Excessive Mean Delay Summary for Non-Priority - Short Packets

Acceptive mean peray cummany non-finding by a city of ache is	TOT WOIL-ET	יים ביים ביים ביים ביים ביים ביים ביים	or v rachers	
Network Configuration		Traffic S	Traffic Spike Level	
	809	70%	80%	20%
Fully Operational	ı	1	ı	over
Trunk Loss				
Albany - Ft. Detrick	1	1	over	over
Andrews - Tinker	1	1	over	over
Ft. Detrick - Tinker	1	1	over	over
Pt. Detrick - Gentile	1	ı	•	over
Gentile - Tinker	ı	1	OVEL	over
Link Loss				
Albany - Ft. Detrick	ı	•	over	over
Albany - Andrews	1	•	over	over
Andrews - Hancock	1	ı	over	over
Andrews - Ft. Detrick	i	1	over	over
Andrews - Tinker	t	over	over	over
Ft. Detrick - Gentile	1	•	ı	over
Ft. Detrick - Tinker	ı	1	over	over
Gentile - Tinker	1	i	over	over

TABLE XII (CONT'D)

evel	90%			r over	over
ic Spike L	<u>70%</u>		over	over	ı
Traff	20%		over	over	•
		•	over	•	ı
etwork configuration		Node Loss	Ft. Detrick	Gentile	Tinker

TABLE XIII

Excessive Mean Delay Summary for Non-Priority - Long Packets

Traffic Sp 20%	Traffic Spike Level	20%
t	ı	•
1	ı	over
1	•	over
ı	ı	over
ı	1	over
1	•	over
1	ı	over
ı	•	over
1	ı	ı
i	•	over
t	ı	over
ŧ	1	1
t	1	over
ī	ı	ı
20 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		

TABLE XIII (CONT'D)

	808		over	over	over
Traffic Spike Level	80%		OVer	1	•
Traffic	20%		over	1	•
	<u>809</u>		OVer	1	•
Network Configuration		Node Loss	Ft. Detrick	Gentile	Tinker

The last table, Table XIV, gives a summary of when the algorithm was not well-behaved as defined by the author previously. To restate, if a packet has a mean delay greater than or equal to 570 msec for short packets and 795 msec for long packets or has a maximum delay value greater than or equal to 2025 msec for short packets and 2250 msec for long packets, then the algorithm is said to be not well-behaved at the traffic level in which the excess delay occurred. The "dashed" entries represent when the algorithm was well-behaved and the "X" entries correspond to when the algorithm was not well-behaved.

The last chapter presents the conclusions and recommendations of this paper.

TABLE XIV

Algorithm Behavioral Ability (non-priority, short/long packets)	avioral Abi thort/long p	lity ackets)		
Network Configuration		Traffic	Traffic Spike Level	
	809	20%	80%	808
Fully Operational	1	ı	•	ı
Trunk Loss			٠	
Albany - Ft. Detrick	ı	ı	•	1
Andrews - Tinker	1	ı	•	×
Ft. Detrick - Tinker	•	1	1	•
Ft. Detrick - Gentile	ı	1	1	,
Gentile - Tinker		ı	1	•
Link Loss				
Albany - Ft. Detrick	ı	ı	×	×
Albany - Andrews	ſ	ı	•	1
Andrews - Hancock	ı	ı	•	ı
Andrews - Ft. Detrick	ı	ı	•	×
Andrews - Tinker	t	ı	1	×
Ft. Detrick - Gentile	ı	ı	ı	1
Ft. Detrick - Tinker	ı	1	•	ı
Gentile - Tinker	ı	1	1	1

	20%		×	×	×
Traffic Spike Level	80%		×	,	ı
Traffic S	20%		×	1	•
	809		×	•	
Network Configuration		Node Loss	Ft. Detrick	Gentile	Tinker

IX <u>Conclusions/Recommendations</u>

The purpose behind this paper was to determine the adaptability characteristics of the hierarchical routing algorithm developed by System Control, Incorporated for the AUTODIN II computer communications network. A computer simulation program was written to model the network with the routing algorithm written in Fortran and incorporated into the simulation program.

Two network parameters were varied, traffic volume through the network and network topology in an effort to cause the routing algorithm to adapt to these changing network conditions. By taking picture "snaps" of the network status every second after a traffic spike occurred, a general idea was formed as to how the algorithm was adapting. The output statistics obtained during these "snaps" were consolidated in the form of graphs and tables in Appendices F through I.

The previous chapter presented a summary of these graphs using accepted statistical procedures in order to help the reader form some opinion on the adaptability of the routing algorithm.

Having completed the simulation exercise the author has formed these conclusions:

- (1) under moderate load and no loss of primary facilities, the algorithm adapts very well and does not cause undue packet delay.
 - (2) the occurrence of traffic spikes and network top-

ology changes has little or no effect on the delay incurred by priority packets regardless of their size.

- (3) under moderate load and no loss of primary facilities, the disturbance period is from four to five seconds.
- (4) the algorithm is well-behaved during the majority of simulation runs, but in some cases, does cause packets to incur delays of up to (and exceeding), six and one half seconds.

Recommendations

Throughout the simulation exercise there were two links that were always first to get congested. The Albany - Andrews link and the Andrews - Hancock link only contain one trunk each. It is this fact plus the amount of traffic volume they carry that causes the link to become congested. It is recommended that one additional trunk be allocated to those two links.

If the additional software overhead would not be too costly, one change is recommended in the area of the algorithm that builds the trunking routing table, TTABLE. In addition to evenly distributing the number of packets queued for output on multi-trunk links, it is recommended that the distribution of packets based on packet length also be used. Since time of transmission is directly proportional to the longth of a packet, this additional qualification on packet errimetion to the trunks could possibly reduce packet wait-. . output queues and thus reduce the overall delay

time.

The last recommendation is one of individual implementation of the algorithm subroutines into the simulation model. Instead of having 64 subroutines (eight copies of the algorithm) to represent the algorithm at the eight nodes, the implementation should be changed to have only one copy of the algorithm but accessible by the eight nodes. If this could be accomplished, then when additional nodes were added to the network, they too could access the single algorithm copy. Otherwise for each new node added to the network, eight subroutines would have to be written for that node's copy of the hierarchical routing algorithm.

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Appendix A

Baseline Simulation Code for the Andrews Node

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LyJ/11,10 17.2, 17.2/13, 355.4, 5097.6, 1.057.0, 915/7,1.2/175,1.38

LyJ/11,1/14, 12.03/2012,12/19, 2.3/192,2.52/14,22.81/193,2.99/195,33.2

Lylin/14, 12.03/2012,12/19, 2.3/192,2/2/2012,2/2/2013,2

经给水车 经存款 人名英格尔姓氏 水水溶液 经银铁 医拉斯耳 医水子染液 医人名英格兰 化二苯化亚二甲苯胺丁酚甲

DESIZ F.HG.134 RN2,D0 DESTINATION DISTRIBUTION AT NODE ANDREWS 1154+17.5663,2/.F893,3/.6532,+/.7777,5/.8355,6/.8933,7/1.0,8 **(**

(FIRST) (FIRST) (FIKST) (SECOND) SECOND) (SECOND) (FIRST) (SCH 2) (SECOND) PAIDRITY FOUTES FOR PADCESSING TIMES (SCH 1) LENGTH KUUTES FUR XMISSION TIMES (SCH 1) LENGTH LOUTES FUR XMISSION TIMES (SCH 1) (SCH (SCH LENGTH LOUTES FOR XMISSION TIMES (SCH PRIORITY ROUTES FOR PROCESSING TIMES LEAGTH ROUTES FUR XMISSION TIMES LEAGIH ROUTES FOR XMASSION TIMES LENGTH POUTES FOR XMISSION TIMES KOUTZ FUNCTION PHI,LB ROUTING AT NODE ANDREWS ANIKII/2, TERM?/3, ANDL2/4, ANDL2/5, ANK31/6, ANDL4/7, ANKII/8, ANDL4 PH3,L2 PH2,L2 PH 3, L 2 PH3, L2 PH3, L2 PH3,L2 PH2, L2 PH3, L2 1, LUP22/2, 41 P22 19A4542/20A4L +2 L. LUPZ1/2, HI 721 PKL 22, FUNCT 101 1, ANS 22/2, ANL 32 ANF 41 FUNG: 10N 1,44541/2,442)1 ANF11 F 1001 704 AINSES FINDLEDA MALLE FINGTION PNSE+ FUNCTION PRI 21 FINCTION ANF 22 FUNCTION 1924511/20151111 13 ANS 31/20 ATL 31 1,41,1521/2,1111.21 È Θ

	THFUZ FUNGTION	РН3, L2	LENGTH ROUTES FOR TERHINATION DECISION. SHORT PACKETS/LONG PACKETS
	THPS2 FUNCTION 1,ANLUS/2,ANHIS THPLZ FJNGTION 1,ANLUL/2,ANHIL	PH2, L2 PH2, L2	PRICKITY KOUTES FUR TERMINATION DECISIONS. SHORT NON-PRIZSHORT PRI PACKETS PRICKITY ROUTES FOR TERMINATION DECISIONS. LONG NON-FRIZLONG PRI PACKETS
®	* KIIME 148LE KIMIS TABLE KIMIL TAALE KILOS TABLE FTLOL TABLE	M19269200 M19209200 M19209200 M19209200 M19209200 M19209200	TCTAL POCKET DELAY. TOTAL P.IT-SHOKT PACKET DELAY. FOTAL PRIT-LONS PACKET DELAY. TOTAL NON-SHUKT PACKET DELAY. TCTAL NON-LONG PACKET DELAY.
	\$ \$ 6 6 7 4 7 4 6 6 6 6 6 6 6 6 6 6 6 6 6 6	***	电电话电路 医非血管不安止性 人名布雷斯特 医格特奇 医格奇奇氏 医生物管膜炎病 人名英西西西哥
•	NODE LNDREW S SWITH L LDGI F LDGI F LDGI F LDGI	LNDREWF PRUCESSING GENTER 2 SWITCH CONTROL MODULES (SCH) 4 LJGITAL TRANSHISSIOH LINKS 5 PHYSICAL TRANSHISSION LINES 11 ***********************************	NOJE LNDREWF PRUCESSING GENTER 2 SWITCH CONTROL MOJULES (SCH) PDP11/70'S + 4 LJGITCH TRANSHISSION LINKS + 5 P 17SIGAL TRANSHISSION LINES (TRUNKS) + 6 P 17SIGAL TRANSHISSION LINES (TRUNKS) +
⊗ `	AUNRE GENERATE ASSIGN ANUK ITANISEER	2 U,FN&EXP3N 4, 9, 2 • U1,, HIGH?	GENERATE FACKETS & 23% SAT MEAN OF 26 MSEC SIDKE IN PARA 4 SOURCE NODE ID=2ANDREWS.
@	HIGH?	2,1 ,60N21 2,2	HACK THIS PACKEL WITH NON-PELICATION STONE IN PANA 2 FHE PAIDKITY OF 1. JUMP TO CCHTINUE. HART THIS PACKET WITH PRIORITY. CLASS IN DALAR 2 THE PAIDKITY OF 2.
0	Can 21	.62, LONG2 3, 1 , CONZ2	
<u>@</u> @	CON 22 ASSIGN CON 22 ASSIGN TANFER	35.4 1,FREDEST? • 5,4NUY1,1NDY2	SEND HALF OF FKIS TO PROCESSORS #1 4 #2 RESP.
	* NETMUNK PARKETS ENTER THE ** ATTIVITY - FOR SCH #1		A:JOREMS NODE AT POINTS!

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SIDNE LENGTH OF ALPHAY TRAKI, LINKI.
SIDNE LENGTH OF DETRICK TANKI, LINKE.
STONE LENGTH OF DETRICK TANK?, LINKE.
SIDNE LENGTH OF HAUGOOK TRNKI, LINKI.
STONE LENGTH OF TINKEP TRAKI, LINKI.
STONE LENGTH OF TINKEP TRAKI, LINKY.
STONE LENGTH OF TINKER TRAKE, LINKY.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            GEPENDING ON DESIN, XFER TO CORRECT LINK.
                                                                                                                                                                                                                                                                                                                                                                          XFER DEPENDING ON PRICRITY OF PACKET.
ALD F MSEC FOR NOW-PRICRITY PROCESSING.
                                                               XFEN DEPENDING ON PRIORITY OF PACKET. ACU F MOSE FOR NON-PRIORITY PROCESSING.
                                                                                                                                                                                                                                                                                                                                                                                                                                                           SIDEE LENGTH OF ALBANY IRNKI, LINKI.
STORE LENGTH OF DETRICK TRNKI, LINKI.
STORE LENGTH OF DETRICK TANK?, LINKI.
STORE LENGTH OF HANGOOK TRNKI, LINKI.
STORE LENGTH OF TINKER IRNKI, LINKY.
                                                                                                                                                                                                                                                                                                                                                                                                            JUMP TO CENTINUL.
ALD 3 HREE FOR PRIJAKITY PROCESSING.
KELEASE THE PROCESSUR.
                                                                                                                      ATO 3 MOSC FOR PRIORITY PROCESSING.
KELLASE THE PROCESSOR.
                                                                                                                                                                                                                                                                                                                        ENTER THPUT OUGUE.
SEIZE THE PROCESSON FOR SCRVICE.
LEAVE INPUT QUEUS.
            ENTER INPUT QUEUE.
SELTE THE PROCESSOR FOR SERVICE.
LEAVE INPUT OUGUE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           LINK 1 IS MADE UP OF 1 TRUNK TO ALBAHY.

LINK 2 IS MADE UP OF 7 TRUNKS 10 FT.DETRICK.

TRUNK 2 IS CURNECTED 10 SCM 1.

TRUNK 7 IS CURNECTED 10 SCM 1.

LINK 1 IS CONNECTED 10 SCM 2.

TRUNK 1 IS CONNECTED 10 SCM 2.

LINK 4 IS CONNECTED 10 SCM 2.

TRUNK 6 IS CONNECTED 10 SCM 2.

TRUNK 6 IS CONNECTED 10 SCM 1.
                                                                                                       JUMP TO CONTINUE.
                                                                                                                                                                                                                              12,0;AR041,XL
13,03AN012,XL
FN, 40U12
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13,02AND72,XL
FN,RUUT2
                                                                                                                                                                                              16,02AN922,XL
11,04AH031,XL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          11,02ANQ31,XL
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SCH PRICESSOR #1
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	* ANDRE	ANDREMS QUEUE LE	LENGTH DECISIONS				
3	ANDLZ	7257 LE 728 NS FER	gsand21, of Ang22, ank22 , ank21	ANK22 IF	021 <= Q22,FALL THRU-ELSE QU LNK TO OUEUE ON LINK 2,1.		2,2.
	ANDL	TEST LE TANSFER	Osang41, of But42, Ank42, Ank42	ANK42 IF	P41 <= Q42,FALL THRU-ELSE QU LNK TO QUEUE ON LINK 4,1.	L X	4,2.
<u>@</u>	1E1.42	TARULATE	RTIME		THIS PACKET'S TOTAL DELAY.		
	THANS	T KANDERA TEANSFOR	FIN, LAFOR	SASED ON			
	NAMC A	TRANSFER	FN,TMPL2	BASFO CIT	PACKET PD: EXM		
(274	TEKTE		DELIVER	DELIVER PACKET LOCALLY AND LEAVE NETHORK.	Α×.	
ě	ANHIL	149UL ATE 12341 RATE	K] HIL	TABULATE DF. IVER	TABULATE PRI-LONG PACKET DELAY. DELIVEK PACKET LOGALLY AND LEAVE NETMORK.	ž.	
	FNLOS	TAMBLATE	KTLOS	TABULATE	145ULATE DON-SHORT PACKET DELAY.	3,4	
	ANLOL	1 AG UL ATE	KILOL	TABULATE		•	•
_	,	TER 41 NATE		DE-IVER F	DE_IVER PACKET LOCALLY AND LEAVE NETWORK.	¥ ¥	
	ಶ . * *	OUTPUT PROGES	PRICESSING FOR SCH 1.				
	ANK22	RJEUE	A NG22	ENTER OUT	OUTFUT QUEUE FOR TRUNK 2,3.		
•		SE17E	ANTK3	SEI7E 18	1 JUNK 2,3 FOR SERVICE.		
		DEPART	AN022	OFPART OF	DIPART GUIPUT OULUE.		
	A13.22	TRACEFER	FN, ANF 22	AGO 27 MG	XEEK CEPERCING ON PROXET LENGTH. AGO 07 KAFO FOR PACKET XAFONION.		
		TANASFER	, Cuit24	JUNE TO	CONTANCE		
	. ANL 22	ADVAVCE	100		MSEC FOR PACKET XMISSION.		
	C0/15+	14 EL EA SE	ANJK3		TKU14K 2,3.		
	. 4	TRANSFER	, FTDE1	OT AMOU	NODE FISDERRICK.		
	ANK41	30,500	A 1404.1	ENTER 097	OUTFUT DUEUE FOR TRUNK 179 +.		
	•	SEIZE	ANTKG	SEL7E THE	SELTE THUNK 4,4 FOR SERVICE.		
	•	05PAFT	A 14 05 1	SEPART OF	DEFERRY DOING DUESTE.		
	AUSAI	A 3V A 12 C F	7 Ng MNF 41	AD3 27 %S	27 *SEC FOR PACKE! XMISSIUM.		
		TRANSFER	, CON25	JUMP TO	JUMP TO CONTINUE.		
	ANL 41	A DV NIGE	001		MSEL FOR PACKET XMISSION.		
	CON 25	hal sa SE	ANTK		TAUNK 4*4*		
		TAMUSFER	, TNKKZ	104410	NODE IINKER.	•	
	ANK11	ANK11 OJENE	ANG11	ENTER OU	ENTER DUTFUT QUEUE FOR TRUNK 1,6. SELZE TRUNK 1.6 FOR SERVICE.		
		7 720		4:410	110 to 10 to	•	

		DSPART		DEPART DUIPUT QUEUE.
		1 3A YSFER	FN, ANF 11	XFER DEPENDING ON PACKET LENGTH.
	ANS 11			ADD 27 MSEC FOR PACKET XMISSION.
			ONZE	JUMP TO CONTINUE.
	A14L 11	ADVANCE		AND 100 MSEC FOR PACKET XMISSION.
	CU1125	RIL EASE	ANTKE	RELEASE TRUNK 1,6.
		Tay longs	, ALPNZ	JUMP 10 NONE ALBANY.
•				
→ 4	ŏ • •	OUTPUT PROCESSING FOR	SSING FOR SCH 2.	
	ANK 31		ANG31	ENTER OUTFUT QUEUE FOR TRUNK 3,1.
		SELZE	ANTK1	SEIZE THUNK 3,1 FOR SERVICE.
		0≦P4₹ T	AN031	DEPART OUTFUT OUGUE.
		TRANSFER	FN,ANSEG	XFER DEPENDING ON PACKET LENGTH.
	AI45 31		27	ADD 27 MSEC FOR PACKET XMISSION.
		T KANSFER	, CON27	JUMP TO CONTINUE.
	AINL 31		100	AFD 116 MSEC FOR PACKET X4ISSION.
			ANTK1	RELEASE TRUNK 3,1.
		TANSFER	, HANCK	JUMP TO MODE HANGUCK.
•				
	ANK 21	OUFUE	A N 021	ENTER GUTFUT QUEUE FOR TRUNK 2,2.
		Sil7c	ANTKZ	SFI7E TRUNK 2,2 FOR SERVICE.
		DEPART	A N 0 2 1	DEPART OUTPUT QUEUE.
	-	TRANSFER	FILTUSES	XFER DEPENDING ON PACKET LENGTH.
	AN3 21	AUVANCE	12	ALD 27 NSEC FOR PACKET XMLSSION.
		1 (A USFER	, CUN28	JUMP TO CONTINUE.
	:::	1000000	7	ADD ALCO HODG FOR PACKET XMISSIOM.
	CON 25	RELEASE	ANTK2	TEUNK 2,2.
•		1.44 NOF ER	, FTOE3	JUMP TO MODE FT.DETRICK.
٠,	•			
ക	414K42			ENTER OUTPUT QUEUE FOR IRUNK 4,5.
,		32 TES		SEIZE TRUNK 4,5 FUR SERVICE.
		DEP 4 H	A 110' 2	DEPART GUIPUT OUEUE.
		TRAMSFER	5 E4	XFER DEPENDING ON PACKET LENGTH.
	ANS42	A JV ANCE		ADD 27 HSEC FOR PACKEL XMISSION.
		1 KAUSEEN	.29	JUMF 10 CCNTINUE.
	ANC 42			ADD 116 MSEC FOR PACKET XMISSION.
	CO1524		ANTKS	RELEASE TRUNK 4.3.
	. ,			LOAK TO LOD! TINKER.

Zu MSLC. 07 MSLC. MSEC. MSEC. MSEC. MSEC. MSEC. MSEC. MSEC. STATS. 70% SAT. TEXMINATE THIS TIME PERLUD.
RUN FOR 5 SECS 10 REACH SIEADY-STATE.
QUALUL-QITKQLI WIPE OUT INIT. STATS.
RUN FOR 31 SIMULATED SECONDS AT 26% SATGEN. FACKETS 8 UX SAT. - MEAN OF 26 M3 GEV. PACKETS 8 60% SAT. - MEAN OF 26 M3 GEV. STATS. 13 GEN. PACKETS & 60% SAT - MLAN OF 11 GEN. PACKETS & 60% SAT - MLAN OF 11 GEN. FACKETS & 60% SAT. - HLAN OF 31 GEN. FACKETS & 60% SAT. - HLAN OF 31 GEN. FACKETS & 60% SAT. - HCAN OF 31 GEN. FACKETS & 60% SAT. - MCAN OF 31 GEN. FACKETS GEN. PACKETS & 70% SAL. - NEAN OF GEN. PACKETS & 70% SAT. - MEAN OF OTALOUI-29TKO41 HIPE OUT 70% STA Ä 0 66% SAT. - MEAN O GLN. PACKETS 3 , 3% SAT. - MLAN GFN. PACKETS 3 / 70% SAT - MEAN U GEN. FACKETS 3 70% SAT. - MEAN GEN. FACKETS 3 70% SAT. - MEAN GLN. FACKETS 3 70% SAT. - MEAN GLN. PACKETS 3 70% SAT. - MEAN CANALUUT-03 TKO5.1 WIPE OUF 2CX - MARK 100 TOO MLAN - McAN ECOND AT ECO 1D AT 202 100 GEN. PACKETS & UDX SATOREN. PACKETS & UCX SATOREN. KUN FUF UT SIMULATED S GEN. PACKETS & BUZ GEN. PACKETS & BUZ 014L0U1-21TK041 ZwyFNAEXOON GEN. FA G79FN-EXOON GEN. FA F\$ALPS1-F\$TKTKG, Q*ALQU1 F&ALPS1-F\$TKTKB, F\$ALPS1-F\$TKTK5 3ALPS1-F\$TKTK6 F\$ ALPS 1-F\$TKTK 199,FNAEXON 118,FNUEXON 17,FNLEXON CCSF FA EXON 9CSF FA EXON 15 FN LEXPON 28 FN TX POR 61,, 11 21, FRLEXON 61, FRLEXON 81, FRLEXON 13, FRLEXON 24, FRLEXON 17,FN&EXPON GU,FN&EXTON 31,30 26,FNEXPON 32, FNL EXPON 26, FNL EXPON 31, FN LEXPON 11,FNSEXPON 2U,FN,LXPJN 29,FN,EXPJN 2,FULEX 2)N 22,FN3.EXP34 17, FNT LXPIN 22, FN: EXPIN 22, FN& EXPON 15, FN: EXPON 23,FNJEXPOR Ud, FNELXPOP 11, FALCXPON 01,061 668 8 A T B S T B GUILIATE SIA START ANDAE FTDET GLATE HANCO 12 NKE AL JAH FLUET GE.477 ANDRE FTUET HA.4CO ALSAN MOULE HA 100 Printer LNKL GENTE HARRO 3 Θ 8

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FAALPS1-FSTKTK6, GLALOU1-05TKG41 RESET STATS EXCEPT THESE.
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KESST KTAST KTSST STAST

Appendix B

Sample of Hierarchical Algorithm
Coded in FORTRAN

Example of
Ft. Detrick's Copy of the Algorithm

AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOO--ETC AN ANALYSIS OF A ROUTING ALGORITHM FOR AUTODIN 11.(U) DEC 79 JA MHITTENTON AFIT/DECE/ZE/79-15 NL AD-A080 484 UNCLASSIFIED NL 3 0 € 5

0ELD(2) = 1.0 0ELD(3, h) = 1.0 0ELD(3, 3) = 1.0 0ELD(4, 4) = 1 MFI 0ELD(4, 5) = 1.0 0ELD(9, 5) = 1.0 INITIALIZES THE P ATRAY (CONNECTIVITY POINTER A RRAY USED 10 POINT TO THE FIRST ENTRY IN THE NC ARRAY FOR CURRENT SELF HODE) AND THE NO ARRAY FOR CUNTAINING THE TOTAL FYINS HODE NUMBERS CENNECTED TO CORRENT SELF HODE. THE THRA DISTANSE FIRE (CINTED THE NUMBERS THE CORRENT STATE THE CORRENT THE THE CORRENT TO COLOR COLOR CONTROLLY OF THE NETWORKS IN 'S ENTRIES OF THE COLOR CONTROLLY OF THE NETWORKS IN 'S ENTRIES OF THE COLOR CONTROLLY OF THE NETWORKS IN 'S ENTRIES OF THE COLOR CONTROLLY OF THE NETWORKS IN 'S ENTRIES OF THE COLOR CONTROLLY OF THE NETWORKS IN 'S ENTRIES OF THE COLOR CONTROLLY OF THE NETWORKS IN 'S ENTRIES OF THE COLOR CONTROLLY OF THE NETWORKS IN 'S ENTRIES OF THE COLOR CONTROLLY OF THE NETWORKS IN 'S ENTRIES OF THE COLOR CONTROLLY OF THE NETWORKS IN 'S ENTRIES OF THE COLOR CONTROLLY OF THE NETWORKS IN 'S ENTRIES OF THE COLOR CONTROLLY OF THE COLOR COL DELD(1,8)=1.3 DELD(2,4)=INFI DELD (5,8)=1NFI 050.0 (6,5) = INFI DELO(6,8)=1.3 DELD(7,3) = INF1 INFESC. PALEVA(0), RLO(2,1), VAR(1), FUR(2,1), BVA(1), CHA(3,1)
INTESET FAC(5,1), GNU(1), MSA(1), LOG(1), DUC(4,1), STO(7,1), TAB(9,1)
INTESET FAC(1), FSA(1), MBA(1), FMA(1), LMA(1), RSA(1) DELD(6,4) = 1. PLLO(8,4)=1. INTEGE (*)CS, OERC, DEP, JLA4, DERT, PLN2, OFHOP, DELLIST, DEAFLD, DERUP, *DE SELF, PANLI, DEE, DEROJT, JESP DI, SELIKS, GEPUFF, DEAUFT, DEPARM, *DE COVE, ATTI, DETZ, DESTJS SUBROUTIVE DEINT (PARAVA, BLO, VAR, FUM, BVA, CHA, FAG, GRO, HSA, LOG, * QUE, STO, TAR, FHA, FSA, H4A, BHA, LHA, PSA, SAVVDE) COMMONZOSTA LZOCLO(&,3),9EP(9),1NFI,9ENN,DFRC(32),DEPUUL(0), *DED(3,c),DEPUP(C),GELEST(32),DESELF,DFRLN,DLS,DEE,DES (OT (A), *DELI 18(1),DFRUFF(S),DETOFT (12),DEFFLO(S),DEPANM(6),DFRUP(O), *DEZONT,DATI,DETZ,DESTJS(2) DELINS(+) ### COLO (2,3) ### OF COLO (2,3) ### OF COLO (2,3) ### OF COLO (3,3) ### OF COLO (3, DELF(6,3)=1.0 DELE(8,7)=14FI DELIMS (3) = 3 \$ ULLO(5, 2) = INFL 4 ULLO(5, 2) = INFL 4 ULLO(6, 3) = INFL 4 DELP(()2)=1.t. 3 DELP(()5)=1.t. 3 DELINS(2) = 2 t E DELD(7,2) = INFI DEL 3(7,3) = 1.[DEL7(5,2)=1.0 DELENS (2) HUY CONNECTED. 01LD(3)11.6 3 01LD(5,7)=1.7 5 02LD(9,1)=10FI 5 02LD(8,3)=1.0 8 02LD(8,3)=1.0 8 DELD(3, 7) = I'F1 051.9 (7,5) = TUF1 01:L9(4,5)=I'F1 92c0(1,1):IUFI DELO(1,5) = IV.FI 5ct0(5,5)=TFFI 5ct0(5,1)=TFFI REAL STAVOS (1) D: LD (2,1) = 1. J OELD(5,1)=1.0 ULL3(2,3)=1.6 DCLD(7,1)=1.0 115 = 1900 RUAL BUFF DELALI 00000000 . (a) Ò Š ٥

INITIAL O INITIALIZES FHE D TABLE AND BUILDS THE HOP ARRAY(NO. OF HUPS FEDULAED TO GET TO THE INDIVIDUAL CONNECTED NODES) AND THE LIST ARRAY(ARRI) OF ACIDAL CONNECTED NODE NUMBERS). DELIS(5) = 2

DESTEC(1) = 1 * DEBFID(2) = 4 * DEBFID(3) = 6 * DEBFID(4) = 9

DESTEC(2) = 11

DO 4) DEVI=1,DEAN

DO 7) DENZ=1,DEAN

TO (701) (001,1,0EAN)

TO (701) (701) (701)

TO (701) (701) (7 INTESER PARTYALS) COTMONZOSTAML/DELD(4,3),9EP(9),INFI,DENN,DENC(32),DEROUT(4), UPALM = OFP (DESELF+1) - OFP (DESELF) DO 0.1 [=1,FENN SAVVO: (/2+I) = DELD(DESELF,I) SUBMOUTINE DEINID(PARAVA) DEPOSITIVE + 1) = DES DEVC(ES) = -DEN2 GU TJ 3 0440(573) = +DEN2 DEBUFF(I) = U ULS = nES + 1 UO -3 I=1,32 DEL13T (?) = 0 11 015115 = 3 0612 = 20 0612 = 20 DESTUGATOR COAT TRUE (T) ent 30 CONT TRIVE COMITME COAT INDS Dr 70 16 7 35 . . 3 r. ၁၀၁၁၁ **(u)** 0

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*ueD(J,R), DFMOP(B), DEL[ST(32), DESELF, DENLN, DES, DEE, DESROT(B), *UELL IS(T), DFRUFF(E), DFEUFT(12), DEBFTO(*), DEPARM(6), DE BUP(6), *OLTO, IL, DET1, NET2, UEST1S(T), DENL, DENLN, DEMOP, DELIST, UEBFTO, DF9UP, *OLTOFERP, DES, DENC, UEP, DFM1, DENLN, DENDP, DELIST, UEBFTO, DEPUF, DEPARM, *OLTSELF, DEMULI, UEF, DEK, DFAOT, DESTOT, DELIANS, DEBUFF, DEAUFT, DEPARM,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         DESO ID TAKES THE INITIAL O TABLE BUILT BY DEINID AND FILLS OUT THE ABST OF THE TABLE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CO14334/235TAFL/UELD (-,3), 33P (9), INFI, 9ENU, DENC (32), DERUUT (9), 9E94(3,0), DEFLOP(6), DELES (32), DESELF, DENEN, DES, DESSOT (3),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   SUBKOUTINE PECOMD (PARAVA)
                                                                                                *9EZU 1.93ET1, DET2, DESTJS
                                                                                                                                                                                                                                                                                                                                           CEHOOCH) = INT (INFI)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       DED COP141,02P) = 1.6
                                                                                                                                                                                                                                                                                                                                                                                                                                            DU 93 1=TT,KK
tell = ngHC(1)
IF (35H1) E(,80,70
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       04(13) (05() = 06(1)
                                                                                                                                                                                                                                                                                                                                                                                                                            KK = DE2 (1+1) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    INTEGER PARMYA(S)
                                                                                                                                                                                                                      00 : J L=1, PENLM
00 : J J=1, FENN
050(1,1) = "NFI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DEMOS(DEMI) = T
                                                                                                                                                                                                                                                                                                                        1 57 4=1, PENN
                                                                                                                                                                                                                                                                                   623(3,1) = 0.0
CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                        (C) 4)( = T
                                                                                                                                           J = JESTLF
                                                                                                                                                                                                                                                                                                                                                                 2061TAUT
66462CD =
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                                                                                                                                                                 063 = 1
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END
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**DEZONE, JET1, DET2, DESTJS(3)
INFESER DES, UEH3, UEP2, DESTJS(3)
INFESER DES, UEH3, UEP3, DEN1, DEM1, DELINS, DEBUFF, DEBUFT, DEPARM,
***DESONE, DET1, UET2, UESTJS
***NET LAFT
INTE = 755 - 1
***DOUTS, I = 755, I OEF
***DESONE, UEF
***DESONE, UE
OBEL1 45 (5), OCBUFF(5), OCBUFT (12), OEBFIO(5), DEPARM(6), DEBUP(5),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        1F (Till .67. (DEHOP()EN1) + 1)) DED(DEN1,L) = 1NFI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          GO TO 23
DEDIVIZ = DED(DLMZ,L) + DELD(DENZ,DENI)
LF (DEDVIZ .LT. DED(DENI,L)) DFD(PENI,L) = DEDNIZ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             DO 42 ==1,FEMLN
DECH21 = DEP(DEN1,L) + DELD(DEN1,DEN2)
1F (PCFM21 -LT. DED(DEM2,L)) DED(DEM2,L) = DEDN21
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         TO 50
(DEHQP(DFN2) .6E. INFI) GO TO 45
(OEHQP(DFN2) .6T. DEHQP(DENI)) GO TO 40
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              = DEHOP(D;N1) + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       IF (9642 *N(* 9641) 63 T3 13
INTD = I4T(060(2641,L))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      (OCH2 .67. U) GO T) 33
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        60 TO 35
CONTINUE
IF (OLS .WE. DEF) 60 FD
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         0cLIST(DEG) = 0EN2
0cs = Pgs + 1
                                                                                                                                                                                                                                                                                                                                                                                                                                                         L=1,PENLN
J=DFT,IDEE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     DENI = DELITIOES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 DEAZ = DELISIO)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        KK = [E^{2}(DE)] + 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DO 53 JEINKK
DE42 = DEMC(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             II = 059(0ft1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           - SEO = SEOI
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      0£402(0£42)
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DES = DES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CO TINNE
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CONTINUE
                                                                                                                                                                                                                                                                                                                                                                                                                                                    00 23 1
Du 20
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RETUให END SUAKOJIYE PERTPL (PARAVA, BLO) VAN, FIM, RVA, CMA, FAC, GRO, HSA, LOG. "OUE, STC, TAB, FMA, FSA, HMA, BMA, LMA, BSA, SAVVNE)

DEKTRE TAKE THE INFURIABILING CONFEINED IN THE CURRENT D TABLE, MASSAGES IT WITH THIS OUGUE LENGTHS FOR EACH AVAILARTE LINK AND THE HOP ARRAY TO BUILD TWO ROUTING TABLES (SROUTE-TAPLE USED IF CURPENT NOTE IS THE SCUNCE NODE OF THE PACKET, AND ROUTING TO DEVENT NOTE IS A TANDEM HOOF FOR THE PACKET). THE ROUTING TABLES ARE INDEXED BY NOUE AND THE PACKET). THE ROUTING TABLES ARE INDEXED BY NOUE AND THE FURTHES REPRESENT WHICH LINK TO USE TO REACH THE MEXI TANDEM JOBS. NO WEIGHTING FACTORS ARE INTERDUCED TO BIAS AGAINST CONSECTION (BHOM) AND AGAINST THE USE OF EXTRA HOP ROUTES CONSECTION).

INTESEP 3AFPVA(6), 3LO(2,1), VAR(1), FUN(2,1), BVA(1), CHA(3,1)
INTESE FAC(5,1), GRU(1), 45A(1), LUG(1), 2UE(4,1), 5TO(7,1), TAA(9,1)
INTESE FAS(1), FSA(1), HMA(1), EMA(1), LPA(1), BSA(1)
KLAL SAVAPE(1)
DA 14NSIO 1 OF LOCAL (8)
CO 4103V2) STATL ZUELD (8); DE EF, DE NH, DE ROCH (32), DEKOUT (8), TO 2 O 4103V2) STATL ZUELS (8), DE EF, DE NH, DE SAGE, DESCOT (8), TO E D (9), DE EF, DE NH, DE SAGE, D

DEBUFT(I) = INT(SAVVN=(13+I))

COATINUE IDEJ = 1 J=105J+105JJ

DE 1U=F (I)

103J) = JELTNS(1) PU + I=1,PURLN

DEAL = DEDNOM * 100.

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1F (UBET) :1E. DEHOP(4)) .AND. (DELD .Lf. INT(INFL)) GU 10 50 IF ((UBET) .CT. DEHOP(4)) .AND. (DELD .LT. INT(INFL)) GO 10 3U GO 10 x+1 DELOCL(L) + )FWIT (DED(N,L) -DELD) + DEWZ IF (DESRES) GO TO 45
                                                                                                                                                                                                                                                                                                                                                                                                                  DE (EST = DELOCL(L) + 3F41* (DED(N,L) - DEID)
0E3) C3 = DETEST
DEBUFF(I) = DEBUFF(I) + DEBUFF(J)
                                                                                                                                                                                                                                                                                                                                                                                                                                                IF (OFFIES .LT. DESNES) 30 TO 7(
                                                                                                                        60 10 13
0(L00((L) = 0CUUFF(L)/DELINS(L)
CC4) IEMS
                                                                          00 13 L=1,PENLN
1F (0CLL)45(1) 61. J) 60 10 5
0cL65L(L) = INFI
                            IDEJ = IDEJ + DELINS(F)
IDEJJ = IDEJJ + DELINS(I+1)
                                                                                                                                                                                                                                                                 LEED = THE (LED(N.L.))
                                                                                                                                                                                                                PL3E31 = JMTI
DESGES = IMFI
DO 101 L=1, MEMLN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      DESPOT (N) = L
DESPES = DESTES
GU TO FS
CCATINGE
REFURA
                                                                                                                                                                    1=1,0FHN
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            DE (0.) (A) = L

DE 4E.3T = DET EST

60 TO 23
                                                                                                                                                                                    UL (0.11 (1) = 0
UES (0.1 (1) = 0
                CONTINUE
                                                                                                                                                                       ורי חו
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IF (INT(SAVVDE(1-6)) .NE. 1) 63 TO 3

FSA(3) = 14

1034C = 35PIRM(4)10374 = 3FPIRM(4)

CONTRAINE

95 TO

IF (IDSIA .) E. DESELF)

F54(3) = 13

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COAM-CHANGE UPDATES THE 4D TABLE TO REFLECT IF A LINK HAS DONE UP OR GONE DOWN. THE APFROPRATE LINK COMMECTIVITY ENTRY FOR (HI,HZ) IS UPUATED TO DENOTE THE NEW COANECTLVITY STATY FOR THAT LINK. MESGEN AND UPDATE (WHICH CALL HINHDP AND RIAPLE) SHOULD THE CALLED TO REFLECT THIS NEW LINK DENHECTIVITY STATUS.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   SUJRJUTIVE FECCHG (PARYVA, FLO, VAF, FUN, BVA, CHA, FAC, GKU, HSA, LOG, "OLE, JIO, TAB, FRA, FSA, H4A, BHA, LMA, BSA, SAVVDE)
                                                                                                                                                                                                                                                                                                                                                                                                                                  IF (0) "PUFT(J+1) .GT. DEBUFT(J+2)) GU 10 45
                                                                                                                                                                                                                                  F (0) SUFT(J) .LE. DEBUFT(J+1)) 60 TO 25
                                                                                                                                                                                                                                                                                                                          LE (DERET(J) .GT. DEBUFF(J+1)) GO TO 46
IF (OFFUFT(J) .GT. DEBUFF(J+2)) GO TO 35
IF (IDSRC .EQ. PESELF) GO TO 10 K = DEFOUT(IDSIN)
                                                                                                                            I = 0: LINS(V)
J = 0: 0F10(V)
IF (I -:43. 1) G0 T0 2)
                                                                                                                                                                                                  60 T0 1235
1F (I +F9+ 7) 60 T0 3)
                                                                          1F (< . VE. .) GO TO 15
                                                        K = Dr Sept (IDSTN)
                                                                                                                                                                                                                                                       + - -
                                                                                                                                                                                                                                                                                                                                                                                                  FS1(3) = J + 2
6( 10 1116
                                                                                                                                                                                                                                                                                                                                                                                                                                                    FS1(3) = .1 + 1
                                                                                                             60 TO 1.10
                                                                                                                                                                                                                                                                                           <u>"</u>
                                                                                                                                                                                                                                                                                                                                                               F51(3) = J
60 17 1330
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        60 TO 1111
                                                                                                                                                                                   "
                                                                                                                                                                                                                                                                         60 10 1015
                                                                                                                                                                                                                                                                                                            60 TO 10
                                        G0 T0 15
                                                                                           (1) (3)
                                                                                                                                                                                 FS4(3)
                                                                                                                                                                                                                                                                                           FS1(3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           NETU 23
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             1630
                                                        44
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INFESER FACTS, 1), GRU(1), 45A(1), LOG(1), AUE(4,1), STO(7,1), TAB(9,1)
INFESER FYA(1), FSA(1), HM1(1), EMA(1), LMA(1), BSA(1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           SUBROUTINE DEMSGN (PARAVA, ELU, VAR, FUM, BVA, CHA, FAC, GKO, MSA, LOS, +OUE, STO, TAA, FMA, FSA, H4A, JMA, LMA, 9SA, SAVVDE)
                                                                             MEAL SAVVOE(1)
30443V/OFTATL/DELD(1,3), JEP (3), INF1, JENN, DLHC(32), DEROUT(8),
~ULJ(1), O, DCPOP(0), ULL(ST(32), NESLE, DENNEY, JLS, DLE, UESKOI(6),
~ULL(1), OF SUPF(5), JEPJFI (12), OF PFLJ(9), DEPARA(6), UE JUP(9),
~LF7042, JET1, DET2, DLESTJS(3)
                                                                                                                                                                                                                            INTLGEN DES, DENG, DEP, DEM 4, DEMCH, DELIST, DEBFIU, DEBPTU, DENI,
POSSLIF, DEMLIN, DLE, DEMOJT, DESKUT, SELINS, DEBJFF, DEBUFT, DEPARM,
DE 42, DEMJ, FFSTUS, DEZOAE, DET1, DET2, DESTAT
INTESER PARTVA(6), BLO(2,1), VAR(1), FUH(2,1), SVA(1), CHA(3,1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          DELD(PF41, DFN2) = DESTAT * ABS(DELD(DFN1, DEN2))
                                                                                                                                                                                                                                                                                                                                                                                                                         IF (INT(SAVVDE(14e)) .6T. U) 63 TO 110
                                                                                                                                                                                                                                                                                                                                              IF (THI (SAVVDE (14 C)) .NE. U) GD TO H
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             OFFICE ( ((LT) BOAN IS) INTO COREO
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MESGEN DETECHINES WHETHER OR NOT A CONNECTIVITY/CONGESTION MESSAGE
                                 SHOULD OF GENERATED. THE CONFENT STATUS OF THE CONVECTED LINKS ARE TESTIO AGAINST THEIR PREVIOUS STATUS. IF A CHANGE HAS OCCURRED, A STATUS WESSAUE IN GENERALD TO RELECT THE CURRENT LINK STATUS. NODE SATUPATION IS ALSO TESTIU. IF THE NOTE IS SATUTATED, ALL LINKS AKE CONSIDENED CONGESTED, A STATUS NESSAGED IS GHILL AND SEMI TO ALL COMMECTED MODES.
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INFEGLATERA(1), FSA(1), FSA(1), 844(1), 844(1), LMA(1), 85A(1)
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C-GHECK FOR GARLING NFWR(GUOD NEWS(SAVVDE(141)=0),
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IF ()fFJP(I) *HE* 1) 30 fo 20

DESTUG(I) = DEBUP(L)
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1F (0!PU)(I) -NC. 1503) 50 TO 5
02STUL(I) = DERUP(I)
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SUBROUTINE DEUPDT (PHRAVA, PLU, VAR, FUN, 6VA, CHAL THE TRO, HSA, LOG, OUT, STO, TAR, FMA, FSA, HAZ, 3 HA, LRA, BSA, SAVVOE)
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UE.403" = IAFS (DENC(14) FX + I))
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SAJVA: (72+0FNUUE) = DERUP(I)
                                   00 25 I=1,FENLN
IF (JEPUFF(1) .LT. (DET1+DELINS(1))) GU TO 35
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DE407 = IAPS(PENC(19)EX + I))
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INTEGE PACHVA(S), 9LO(2,1), VAR(1), FUN(2,1), BVA(1), CHA(1), TAR(9,1)

INTEGE PAC(2,1), GAU(1), MSA(1), LOG(1), OUE(4,1), STG(7,1), TAR(9,1)

NEAL SEMA(1), FSA(1), HAA(1), HAA(1), PAA(1), BSA(1)

NEAL SEVONE(1)

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Appendix C

Albany's Definitions of Subroutine Table, Array, Constant and Variable Names ALLD - Link Distance (LD) table (Real), network topology matrix

ALD - D table (Real), contains hop/congestion information

ALP - P array (Integer), used as pointers in the NC array

ALNC - NC array (Integer), list of the connected node IDs to a particular node indexed by the entries in the ALP array

ALROUT - ROUTE array (Integer), identifies the link to take if Albany is used as a tandem node

ALSROT - SROUTE array (Integer), identifies the link to take if Albany is the source node

ALHOP - HOP array (Integer), number of hops required to reach each of the other nodes

ALLIST - LIST array (Integer), list of connected node IDs

ALLINS - array containing the number of trunks each link has

ALBUFF - array containing the number of packets queued for output on each link

ALBUFT - array containing the number of packets queued for output on each trunk

ALBFID - array containing the ID number of the first trunk in each link

ALLOCL - array containing the results of the calculation ALBUFF/ALLINS for each link

ALPARM - array containing the six parameters associated with each packet (from GPSS)

ALBUP - array containing the current status of each link, 1 - connected, 1000 - not connected

ALSTUS - array containing the previous status of each link, l - connected, 1000 - not connected

SAVVAL - array containing the SAVEVALUEs passed to Fortran subroutines from GPSS

INFI - pseudo infinity, 1000

ALNN - number of nodes in network, 8

ALSELF - node ID for Albany, 1

ALTBUF - total number of packets queued for input processing

ALNLN - number of links, 4

ALS - variable pointing to first entry in the LIST array

ALE - variable pointing to last + 1 entry in LIST array

ALZONE - node saturation flag, 1 - saturated, 0 - not saturated

ALT1 - link congestion threshold, ?

ALT2 - node saturation threshold, 17

ALBNOM - congestion bias used in calculations for link selection entries in ROUTE and SROUTE arrays, ?

ALCNOM - extra hop bias used in similar calculations, 7

ALBEST - variables used in calculations to determine the entries in the ROUTE and SROUTE arrays

ALSBES - variable used in calculations to determine the entries in the ROUTE and SROUTE arrays

ALTEST - variable used in calculations to determine the entries in the ROUTE and SROUTE arrays

ALSTES - variables used in calculations to determine the entries in the ROUTE and SROUTE arrays

IDSRC - source node ID of packet (taken from parameter 4 of the packet - ALPARM (4)

IDSTN - destination node ID of packet (taken from parameter 1 of the packet - ALPARM (1))

ALNODE - index value into SAVEVALUEs pointing to the first SAVEVALUE corresponding to the set of SAVEVALUES belonging to the source node of a status packet

Appendix D

Full Network Simulation Program
Case: Ft. Detrick Goes Down

SIMULATE REALLOCATE BLO,3Jun, SV,25J SIMULATE THE AUTODIN II COMPUICATIONS COMPUTER NETWORK

HEINOLK WITH EMPHASIS ON THE CHARACTERISTICS OF THE HEIRACHICAL LEINOLK WITH EMPHASIS ON THE CHARACTERISTICS OF THE HEIRACHICAL LOUTING ALGORATHM 10 BE EMPLOYED IN THE REAL COMMUNICATIONS NETWORK 14 E ELGINIT HM IS WAITTEN USES SIMOLE STRUCK THE ELGINITHM IS WAITTEN USES SIMOLE SIMOLE DESCRIPTION NOTES, SINOE THE FIRST WO LEATENS OF THE SUBKNOTINE NAMES COKKESPOND TO THE PARTICULAR NODE, IE. AL-ALGAMY, AN-ANDREWS, ETC., WITH THE LAST A LETTERS OF EACH SUBKNOTINE NAMES COKKESPOND TO THE PARTICULAR NODE, IE. AL-ALGAMY, AN-ANDREWS, ETC., WITH THE LAST A LETTERS OF EACH SUBKNOTINE NAMES SAME IN EACH NODE, IE. AL-ALGAMY, AN-ANDREWS, ETC., WITH THE LAST A LETTERS OF EACH SUBKNOTINE NAMES SAME IN EACH NODE, IE. AL-ALGAMY, AN-ANDREWS, ETC., WITH THE LAST A LETTERS OF EACH SUBKNOTINE SAME USED FOR TRANSFERANG TRUNK QUEUE LENGTHS FROM THE SAVENORY LOSS ANE USED FOR TRANSFERANG TRUNK QUEUE LENGTHS FROM THE SOURCE NODES, LYFGSEK FOR THE PARKOUTE SUBKNOTINES, THEY ARE USED FOR THE SELECTED FROM NODES, LYFGSEK FOR THE PARKOUTE SUBKNOTINE ALEACH (FRANSACTION) PARAMETER AND PARAMETER TO ONE OF THE FACKLI (FRANSACTION) PARAMETER TO THE PARKOUTE SUBKNOTION HILM A LOGICAL FUNCTION TO THE SUBKNOTION HILM A LOGICAL FUNCTION TO THE SUBKNOTION HILM A LOGICAL FUNCTION TO THE SUBKNOTION.

FOR POISSON PACKET INTERARRIVAL FINES KN1,624 Section 1 EXPON FUNCTION

* SDURGE HONE - ALGANY
* DESTINATIONS AND THEIR INTERIORITON NUMBERS * ALGANY + 1 HAJOUS - 5
* MANDELWS - 3 MOSLELLAN - E * GENTLES - 5
* GENTLES - 4 TIMES - 3

UESTI FJRSTIDN RN2,UD DESTINATION DISTRIBUTION AT NOME ALMANY .14-27,11/.35%6,2/.76011,3/.44735,47.3127,5/.015,6/.J524,7/1.09.8

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	* KUUTING FUNCTIO	N FOR ALBANY	KUUTING FUNCTION FOR ALBANY KOULLS' PICKETS TO A PARTICULAR LINK
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	PRILL FURNISON	PF2, L2	PRIORITY COULES FOR PROCESSING TIMES (SCH 1)
	1, L 1912/2, 41 F11 F4112 F 1401 E0A 1, L 1912/2, 41 F12	PF2,L2	PRIORITY ROUTES FOR PROCESSING TIMES (SCM 2) (SECUND)
Ю	ALF22 FUNCITUM	PF3,L3	LENGTH FOUTES FOR XMISSLOY (IMPS (SCM 1)
	1,ALS22/2,A_L22/3,ALG22 ALF23 FUNG[10N PF3,L	5,4LC22 PF3,L3	LENGTH COUTES FUR XHISSAON TIMES (SCH 1)
	APALSZSZZ941LZSZSPALGZS ALF32 F JUCTIO-1 PF39L3	**ALGES PF3,L3	LENGTH KOUTES FOR XHISSIUN TINFS (SUM 1).
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	1946521/2,40121/3,4021 /Loe, FUNSTID 1 PF3,0	89 ALC21 PF39 L3	LENGTH NOUTES FOR XMISSION TIMES (JCM 2)
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(SCH 2) (SUM 1) (FIRST) SHORT NEW-PRIZHORT PRI PACKETS
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LOVE NOW-PRIZE PACKETS PAICKITY FOUTES FOR TERMINATION DECISIONS. (T HUS) ર્ 5 (SCH 1) (SCM 1) LENGTH GOUTES FUR XMISSION LIMES (SCM 2) LENGTH POUTES FOR TERMINATION DESISION. SHONT PACKETS/LUNG PACKETS (SCH PRIURITY ROUTES FOR PROCESSING TIMES PRIOPILY COUTES FOR PROCESSING IINES AUDITING FUNCTION FOR ANDREWS -- ROUTES PACKETS TO A PARTICULAR LINK LENGTH : JUTES FOR XMISSION TIMES LEAGTH FOUTES FOR XMISSION ITHES LEAGTH LOUTES FUR XMISSION IINES LENGTH FUUTES FUR XMISSION 11:1ES LENGTH HOUTES FOR XMISSION II JES 1,411/11/2,44K21/3,4NK22/4,4VK31/5,4NK.1/6,4NK42/7,TEQM2/8,UVDE2 11194,1/.5453,2/.: 893,3/.0532,+/./???,5/.3355,0/.6930,7/1.0.9.8 ROJTING AT NODE ANDREWS *** *** *** *** NUMBERS かくそんふか たいか コンチューザットラルカテマチ DESTINATIONS AND THEIR IDENTIFICATION ALBANY - 1 HAVOSSK - 5 HOSTU4 TINKER SJUKCE NODE + FILDETRICK 1, And 31/2, Ant 31/3, Aud 31 Huge Pount 34 PFS, L3 1, Anser / 2, Aute 1/3, And 21 ANGER FUNCTION PF3,L3 LyANG92/2, 1VL+2/7, ANGL2 PF2,L2 PF2,L2 PFSLA PF2,L2 PF 5, 3 PF3, L3 ALLUET FORSTON PESSES PF2, L2 PF3, L3 PF3, L2 1,4 1832/2,14L22/3,4NG22 *ANSW1/2, 18211/3, ANCW1 ANSII/2, ANDI 104 PF3, E. ***** FK121 FUNDITON 1, LUPE1/2, 41 PZ1 FK122 FUNDITON 1, LUPE2/2, 41 PZ2 19ANLOSZZONYHES TMPLZ FURSTAUJ 19ANLOLZONHEL NOT TONCE STON ANF 22 F JACT 10 1 THEUS FUNDE IDE 1,1 MA. 15 / 2, THA 1L POTICNET SUMPLION F1.DE1 &LOK ANDREMS AL BANY

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T NUD EL31/ 1/14,0	ROUTE	:	:		:	:	:	ROUTES	:	:		:	SETUCE	:	:	:		UTES KETS/	TOUTE	
PDJIING WT NUDE DEL 22/6, DEL 31/7, /13, TEF 43/14, UNL	PKIUKITY KOUTES	;	:	LENGTH KOUTES	:	:	:	LEVGIH RO	:	:		:	LEVETH :0	:	:	:		LENGTH POUTES FOR 1 SHORT PACKETS/LONG	PELURITY ROUTES FUR	12.5
	PF2,L2 F	PF2, L2	PF2, L2	~	06022 PF3,L3	DEC13 PF3,L3	7, JEL, 2 FF3, L3		OLC12 PFS.L3	2 1 C 1 C 1 C 1 C 1 C 1 C 1 C 1 C 1 C 1	2000 2000 2000	PF39 L 3	m	DEC21 PF3,L3	DEC11 PF3,L3	oficas PF3.13	D E C 1 2	PF3, L2	PF2,L2	
104 P L12/3,0 LL2/3,0					ø. M	W.		Ŋ.	رَجِ	6.1/3,0	1,004 1,000 1,00 1,00 1,00 1,00 1,00 1,0	4 - 101 0 - 101	19/00 11/19/00 (11/04 0 0 0 0 4 1 0 0 0 0 0 0 0 0 0 0 0 0 0	621/3,9 104 P	611/3,0	1,00H33/2,00633/3,0f033	2/3,			-
10013 FUNCION 10c11/2, 0c12 10c-11/10,0c1	PKA 31 FUNCETUN	+LJP31/2+41F31 FAL32 FUNC:101	1, LUPSZZZ, 4, PSZ FR. 33 FUNCI IJN 1, LUPS3ZZ, HIP 33	DEF 22 F JIGT	1,0342c/2,0c622/ fc/15 FJH21164	1,30H15/2,00613/ neful Function	1,00H,272,0u6,27 LEF31 FORGETON	*03H31/2* 3.631/ Ec. 12 F3H0113H	, USH12/2, OLG12/ 6-1-1-1-1-1000, 70.1	1,000.173,0.5173,	13.4.2.9.1. 13.4.2.9.1.	1 FUNCTION	9008117490601194 DE121 FURST 194	1,05H21/2,0_621/3, 0=111 F9N0750M	1,00,411/2,7,611/3, 02,33 FJROTION	9D5H53/29 Dc 63 3v	1,00H 2/2,004	1.19 U3 FUNDE1134 1,1 THFTS/2, THFTL	1888 F 1601104	- しゅいくてこう
1001 1001 1001	PALS	40164 7247	Figure 1	+ LrF3	1,002 FEF1	1, July DEF	1,000 [FF3	1,001 Ce. 1	1900t	10.00	, , , , , , , , , , , , , , , , , , ,	Lessal	700,64 5050	1,054 0.11	1.04	1000	1,004	1.19.1 1.17.1	1995	

	•	!!		(SCH 1) (FIRST) (SCH 2) (SECOND)	13		5)			
		RET X	1;2		SCH.	:	SCH	:	: :	:
STS		NODE GENTILE	,51/9,GE	ING TIM	IIMES (:	TIMES (:	: :	:
PRI PACKETS		DESTINATION UTSTRIBUTION AF 42+12/1 03746/103/4,7/1.018	TILE 41/4,6EL	PAIJAITY LOUTES FOR PRUCESSING TIMES	FUR XMISSION TIMES (SUM 1)	:	FOR XHISSION TIMES (SCH	:	: :	:
9 20		31418 5.374 5.10	GEN GEL	For :	۲ ۲	:	× 25:	:	: :	:
LONG NON-PRIZLONG	CHANGE AND	TION OIS	AT MODE , GEL32/1	4 .00TE		:		:	: :	:
ON UNOT	SOURCE NODE	DEST: FJHOIJON KN2,DA DESTINATION UISTRIBUTION AT NODE GEN- La35,17.2777,27.7943,37.2934,+7.642+527. 037,67.0374,771.098 RCUILHG FUNDTIOLS FOR GENTILE ROULES PACKETS TO A PARTICULAR LINK		Phlukit	LENGTH KOUTES	:	LENGTH COUTES	ŧ	: :	•
	LE LOENTIFICA HAYCOOK HOSTELAN NOSTELAN TILKES	DEST: FJWSTJON KN2,DA LASS,17.2737,27.7943,37.2934,+7 KCUTING FUNDTIOLS FOR GENTLE	1 ",6:L21/							
	GENTILE GENTILE THAC THAC NOON	KN2, D4 543,37 S FOA	PF5, L1 Gel13/	9F2, L2	PF3, L3 GEC31	6EC51 PF3,L3	6 L C 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	6 c C · 1 C P F S • L 3	6 L U 2 C PF 3 9 L 3 G L U 1 2	FF3, L3 FF3, L3 FF3, L3 GEC21
THIL	SOUGE NOBE - TIME - TIM	11 10N 2 4 2 7 4 5 10N 11 10P	. NOUT + FJAST104 1,656111/2,55112/3, 1.,15694/11,04054	1134 11734 11104 11942	6EF 31 FJH3: 10.4 PF3; L 1,65H31/2; 6L631/3; 6E631	1965H1129	1960 M11/2, N. O. 1/2, GCU1 GCC 32 F JNO11.04 PF 3-L M GCH32/2, GC 633/2, GCC22 M GCH F M GC 1704	1,65%2 F.1001.104 1,65%2 F.1001.104 1,65%2 F.1001.104 1,65%2 F.1001.104	1,65 HJZ/Z;6LG7Z/3;6LGZ/Z 6EJ12 FJMG[1] 1 PF3;L 1,65 H1z/Z;6LG1Z/3;6LG1Z	66313 F387133 F735 1,6641372;3.64373,63013 66321 F3831734 PF391. 1,6042172;6.62173,66621
1,F1 LOL/2,FT HIL	SOUGE NOD SOUGE NOD SOUNNI DNS ALD NAY FILEDET ALCK TO GENTILE	DEST: FJMSTTON LaSS:17.27733 KOUTING FUNDE	+ FJUS 11/245 EMS/11	PK1-1 FURNITS 1 1, LUP 11/2, 41 P. 1 PK142 FUNDITU 1, LUP 12/2, 41 P. 2	6cF31 F3H3+10.4 965H31/2+61,631,	658017295_6017 658117295_6017	960 H11759 N. 3117 660 32 F JRC1104 963 H32729 G. 6337	65.41 F3N01.304 46.41.17.24.61.01.11 68.512 F.1451.10.4	,65 H.Z/Z,64 G.C. Z 65 12 FJROF 13 4 95 HIZ/Z,54 G.512/	66513 F 786513 7 4 566413 4 6652 1 F 586713 4 66517 7 4 66517 1 6 6517 1 6
1,5716	on manage	DEST • 1935 • KOU	1,001 1,600 1,1	P. C. F. F. F. C. F.	4.00 gr	1,000 1,000	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1.00 th	1000	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4

14FU, FUNC, 134	PF3, L2	LENGTH POUTES FUR TERBINATION DECISION. SHORT POURETS/LUNG PAUKETS
1962 LOSZ 35 HZ 3 1962 LOSZ 35 15 HZ 3 1962 LOSZ 35 HZ 10 4 1962 LOSZ 35 HZ L	PF2,L2 PF2,L2	PRICRITY GOUTES FOR TERMINATION DECISION. SHORT NON-PRICAHORT P.1 PACKETS PRICRITY AUUTES FOR TERMINATION DECISION. LONG NOA-FRICLONG PRI PACKETS
	- HANDOCK - HANDOCK - HANDOCK - HANCOUN - E	CATLUN NUMBERS *
DEJIC FUNCTION NN2, DB 1034:17-14/13/15/14/14/17/19/14/14/14/14/14/14/14/14/14/14/14/14/14/	NN2, D8 1797, 37, 5438, 47, 11 FOR HANDOOK	DESTINATION AT NODE FANCOCK UESTINATION DISTRIBUTION AT NODE FANCOCK (UESA)17.6941,27.1797,37.5438,47.7267,57.7053,57.5430,771.0,8 RUDIINS FUNCTION FOR HANGOCK RUDIES PACKETS TO A PARTICULAR LINK
1,444K11/2,44K21/3	PF5, LG !, HUK22/4, HVK51/5	
PALUPIG FUNDI 134 1,10PiG / 2,41P35	PF2, L2	PAIORITY POUTES FUR PROCESSING TIMES.
H4611 FUNDIADN PF3,L3 1, H4511/2, 4fL11/3, H4c11 H4621 FUNDI 104 PF3,L3 1, H622 FURCION PF3,L3 1, H822/2, 4fL21/3, H4c21 H4631 FUNCION PF3,L3 1,H4531/2, H4L11/3, H4c31	PF5,L3 ,HAc11 PF5,L3 ,HAC21 PF3,L3 ,HAC22 PF3,L3	LENGTH - DUTLS FOR XMISSION TIMES
14FUS FUNDITON 14TAHAS/20FMHAL 1A-SO FUNDITON 14HALUS/2044HIS	PF3,L2 PF2,L2 .	LENGTH FOUTES FOR TERMINATION DECISION. SHORT PACKETS/LONG PACKETS PRIORITY SCUTES FOR TERMINATION DECISION. SHORT NON-PELYSHORT PRI PACKETS
14FL9 FJR3113N 15H2 LOLZ3 44H1	PF2, L2	

(SECOND) PRIORITY ROUTES FUR PROCESSING TIMES (SCH 1) (FIRS)) DESTINATION DISTRIBUTION AT NODE MCCLELLAN PRIDRITY KUUTES FOR TERMINATION DECISION. SHOW! NOW-PRAZZHOKT PAI PACKETS PRIDRITY KOUTES FOR TERMINATION DECISION. LONG NOW-FRIZHUNG PAI PACKETS LEVOIT COUTES FOR XMISSION TIMES (SCM 1) (SCH 2) LENGTH COUTES FOR TERMINATION DESISTONS SHOCK PACKETS AUUTANS FUNCTIONS FOR MOGLELLEN -- ROUTES PACKETS TO A PARTICULAR LINK : COUTES FUR XMISSION LIMES : : .. U. 1/1.2337, 2/. 6459, 3/. 3032, 4/. 3575, 5/.: 311, 6/. 7620, 7/1.00, 8 : ROJING AT NOOL MCCLELLAN : : 1,71.L11/2,43.L12/3,MCL21/4,M3L31/5,M3.32/6,TERNG/7,UNDE6 : : SUURCE HOUSE - MCCLELLAN
DESTINATIONS AMP THEIR LOENIFFICATION NUMBERS * 如如了《南加尔·斯尼亚山路》在中面《花传》以简为中华水路中南部、即是汉·《· · · · 本文版》的表示:《《帝 : : HISKEI : : HOSTELLAN = 6 HOSTO4 = 7 : : HANCOOK PF2,12 PF2,12 PF3, L3 1,03 H31/2, ML 631/3, HCC31 NCF12 FJ10, 10.4 PF3, L3 PF3,L3 PF2,12 RNZ, DB PF5.17 PF3,L3 PF3,L3 PF 3, L 2 PF2,12 1,43H32/2,4L632/7,MCG32 1,011 FJNG[134 PF3,L 1, MUH12/2, 16612/3, MC012 MOUZI FUNDITON PF3, C 1, MS H21/2, M 621/3, MU021 1, M3 H11/2, 1, 6,1/3, ACC11 PICS SE FUNCTION KOUTE FUNDILIDA HALOZ FUWOLION 1, LUPUZ/2, 47 P52 PRIOT FUNCTION 19LoPul/2.HFD.1 TMFUL FURSEIDA SEST, FUNCTION MORSE FUNDITOR PORTUGATOR OF THE 1,4CLUSZZ,43HIS 1,1FLU FJA31134 1,MCLOL/2, 1545L A.4 Crashs AL Jaky

如此感觉第一笑:"她都是一样,如于最后最后最后简单有一种中华的,就不像此人也是一样的非常的"我?我

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PRIDRITY ROUTES FOR LERMINATION DECISION. SHORT NOA-PRIZSHORT PRI PACKELS PRIDRITY ROUTES FOR TERMINATION DECISION. LONG NOG-PRIZZONG PRI PACKERS
                                                                                                                                     DESTINATION DISTRIBUTION AT NODE NORTON
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              LENGTH FOUTES FOR TERMINATION DECISION.
                                                                                                                                                                                                                                                                               PALOKINY ADUTES FOR PACCESSING TIMES.
                                                                                                                                                                                        COUPLING FUNCTION FOR NOCTON -- ROUTES PACKETS TO A PARTICULAR LINK
                                                                                                                                                                                                                                                                                                                                   LEVETH FOUTES FUR XMISSION TIMES.
                                                                                                                                       SHOKT PACKETS/LONG PACKETS
                                                                                                                                                                                                                          ROUTY FUNCTION PERME
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                经由处决备 1.人,帮助死,由斯林多物的现在分词安慰中将"世界军事,是八大","女孩子是不难,在刚儿
             DESTINATIONS AND THEIR IDENTIFICATION NIMBERS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * DESTINATIONS AND THEIR IDENTIFICATION NUMBERS * ALBANY - 1 HANDOOK - 5
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NOSTON --
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MOSTON
                                HANDOOK
                                                                                   TIVEL
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- NORTCN
                                                                                                                                                                                                                                                                                 PF2,12
                                                                                                                                                                                                                                                                                                                                                                      NUGLZ FUNCION PESTS
1,40512/2,40612/3,N0612
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                                                                                                                                                                                                                                                                                                                                                                                                                                            NOUSE FUNDATION PESSES
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              PF3, -2
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HJULZ FOWGIIO4 PF3,L
                                                                                                                                                                                                                                                                                                                                                                                                                        , NUS21/2, 131.21/3, NOUZ1
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SOURCE NO DE
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                                                                 Freneraick -
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                                                    AHDREWS
                                                                                   GLNI ILE
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(SECOND) (SCH 3) (SCH 1) (FIRST) (SUH 2) PAICHTTY ACUTES FOR TERMINATION DECISION. SHOAT NOW-PAINSHOAT PAI PACKETS P+10AITY GOUTES FOR TERMIMATION DECISION. Long mon-frizeong Pri Packets LENGTH POUTES FUR XMISSION TIMES (SUM 1) LENGTH - DUTES FOR XHISSION TIMES (SUM 2) S LEVETH COUTES FOR XMISSION TIMES (SCH 3) LENGTH + DUTES FOR XMISSION TIMES (SCM 2) (SCM 2) (SCH 3) DESTINATION DISTRIBUTION AT NODE TINKER LENGTH FOUTES FOR TERMINATION DESIGN. PRIUNITY GOUTES FUR PRUCESSING TIMES LENGTH SOUTES FUR XMASSION TINES (SCH AJUILNS FUNCTIONS FOR TINKER -- REDIES PACKETS TO A PARILCULAR LINK LENGTH JOUTES FOR XMISSION TIMES LENGTH GOUTES FOR KMISSION TINES : SHOHI PACKETS/LONG PACKETS : : : : : PF2,L2 PF 3, L 3 PF2,12 1,TUH32/2,TUG32/3,11032 11+ +2 FUNGT191 PF3,L3 TAFSZ FARSTANN PF3,L3 PF3, L3 PF 5, L3 PF3,L3 PF3, L3 PF 3, L 3 PF2, L2 PF2,12 1,13H 2/2,T.6 2/7,TIC'2 1,154,2/2, f.6,2/3,1,0;2 T1,22 F04,5/1,34 PF3,t. 1,15422/2, ft622/3,116.2 1,TSH31/2,fL631/3,f1031 | 1201 | FJM3:f07 | 1,TSH5/2,fL631/3,f1671 1,13Hi1/2, F. G11/3, FIC11 11:21 FJN3FI3N PF5, L 1,T54.1/2, FLG, 1/3,TIC+1 1,TSH21/2,FLS21/3,TIG21 11:41 F-HG1.OV PF3,L TISST FUNCTER 341 11 + JN21 101 FAINT FUNDLING 1,LJP3./2,H: Ps1 PREUZ FUMBILLI PALLOR FUNDEROL 1, LUPUR 12 12 P33 TAF 52 FUNDETON 14FUs F1NS1151 1,1NTIS/2,1411C 1, L J P 12/2, 41 P 12 IMPSO FUNCTION THAPE FUNDITOR 1,Til.35/2,T14is 1,1102/2,71HIL

SYSTEM TANLES FOR TOTAL PACKET DELAY

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12 UF PACKETS AKE HIGH PRIDALTY.
DENOTE ALBANY AS SOUNCE NOOF, 17=1.
MHAK THIS PACKET WITH LOW PRIDALIY.
SIDRE IN FARA 2 THE PRIDKITY OF 1.
JUMP TO DOWITHOU.
AARK THIS PACKET WITH HIGH PRIDKITY.
SIDRE IN PAKA 2 THE PRIDKITY OF 2.
SIDRE IN PAKA 3 THE LENGTH OF SHOKT PRICRITS).
JUMP TO SCHILAUGE.
SIDRE IN FARA 3 THE LENGTH OF LONG PRIGITS).
SIDRE IN FARA 3 THE LENGTH OF LONG PRIGITS).
ASSIGN A DESTINATION # (1 = 6) TO PARA 1.
2 SEND HALF OF PKIS TO PRUGESSONS #1 K #2 KESP.
                                                                                                                                                                                                                                                                                         79,FRULLX934,,,, F GEN. PACKETS & 20% SAT. - MEAN OF 79 MSEC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ENTER INPUT QUEUE.
SELTE THE PROCESSOR FOR SERVICE.
LEAVE IMPUT QUEUE.
XFEK DEPENDING ON PRIORITY.
ACD 5 MIEC FOK LOW PRIORITY PROCESSING.
JUMP TO CONTINUE.
100 3 MRS2 FOR HIGH PRIORITY PROCESSING.
                                 F.I.LUNG PACKET DELAY.
NON-PR.I SHUKT PAUKET UELAY.
NON-PWI LUNG PACKET DELAY.
                  PrI-SHU-I PACKEI DELAY.
                                                                                                                                                                                                                                                          李勒斯(中国中央中国中央) 由一点,由一点,一点一点,也是什么的作品,中国中央企业中
  PACKET DELAY.
                                                                                                                                                                                       2 SMATCH CONTROL MODULES (SCM) PCP11/70°S 

- LOGICAL TRANSMISSION LINKS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * NEIMURK PACKETS ENTER THE ALBANY NORE AT POINTS
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701aL
701aL
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HIPAL ADVANCE
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ALPS1

4.0. ALO11, XL

5.3 ALCO11, XL

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6.5 ALC
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LEAVE IMPUT QUEDE.
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THURK 1 IS COUNTEDED TO SCH 1.

THINK 2 IS COUNTEDED TO SCH 2.

THINK 2 IS COUNTEDED TO SCH 1.

THINK 3 IS COUNTEDED TO SCH 1.

I UNIX 4 IS COUNTEDED TO SCH 1.

I UNIX 4 IS COUNTEDED TO SCH 1.

THINK 3 IS MATE UP OF 2 TRINKS TO NORION.

THURK 0 IS COUNTEDED TO SCH 2.
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IF STATUS PKT, TKANSFER.

fabulate This Packel's Total Delay.

Bosio on Packet Length, Transfer.

Bosio on Packet Priolity, Transfer.

Bosio on Packet Priolity, Transfer.

Tabulate Pain-Short Packet Delay.

Tobulate Pauket Locally And Leave Nethork.

Tobulate Packet Locally And Leave Nethork. DELIVER PACKET LOCALLY AND LEAVE NETHURK. 1437/LATE NOM-LONG PACKET DELAY. DELIVER PACKET LOCALLY AND LEAVE NETHORK. DVDELIVERABLE PACKET FERMINATIOM. UFERT JUTPUT DULUE.
KFEK LEPENDINS UN PACKET LENGTH.
ADS 16. ASIG FOX STATUS PACKET PROC.
JUMP TO SCNTINUE.
ADS 27 ASIG FOX PACKET XHISSIUM.
JUMP TO GENTINUE.
ADS 11% 450 FOX PACKET XHISSIUM.
ADS 11% 450 FOX PACKET XHISSIUM.
RELLARF TRUCK 2.3.
JUMP TO AGOR FILDERALDK. XFTS DEPENDING ON PACKET LENGTH.
ALO 1E TISEC FOX STATUS PACKET PROC.
JUMP TO CONTINUE. ENTER OUTFUT QUEUE FOR TRUNK 2,4.
SELZE TRUNK 2,1 FOR SERVICE.
DEPART GUIPUT OUEUE. ENTER OVERU OUGUE FOR TRUNK 2, %. SELZE TRUNK 2, 3 FOR SERVICE. ADD 27 MSIG FOR PACKEL XMISSION.
JUMP TO CONTINUE.
ADD 116 MSLC FOR PACKET X HISSION.
RELEASE TRUME 2... 1 RBHILD IN NON-SHORT PACKET DELAY. JUMP TO NODE FILDETRICK. TRUNK : IS CONNECTED TO SOM 1.

LINK 4 IS MAPE UP OF 1 TRUNK TO TINKER.

TRUNK FILS CONNECTED TO SOM 2. UUTPUT PRICESSING FOR 30M 1. P3,2,ALMEL RTIPE FN, JAFUI FN, TAFUI FN, JAPUI FN, ALF 22 N, 4. F 23 ALIK3 FTDE2 CONTA , CUN14 COMIS. COMIS AL 022 AL 923 AL 722 4 L 1 K + A L 023 RIHIS STHIL RILOS RTLOL 149U_ATE (ER 104ATE 1 4 M N F E 2 A D V A V C B C C O V L V F E L C L S E A L C L S E A L C L S E B A L C 1470_AFE TINH HATE TER 11 NATE ALLOL TABULATE UNDER TENTINATE THALL TRANSFLR ALHIS TAWILTE ALCZZ KOVANCE 1.55.45 FER 40V 1470 TRA 12FER ALLUS TARIJ, LITE 1 LANSFLA ALS 23 ADVINCE TENMY TEST LE TEPASI 0.504.1 ALK22 0 1515 521 10 ALK23 0JEUE S3475 ALS 22 . ALMIL ALL 22 COM 14 11.322 H ➂ $\check{\Theta}$

ALK32 OU	16.03	ALGES	ENTER OUTPUT THENE FOR TRUNK 3,7.
S	1_7:	ALTK?	SELTE TOUR 3.7 FOR SERVICE.
.0	1040	41032	ogeart cutput queus.
~	223 216	FN, ALF32	XFEN DEPENDING ON PACKET LENGTH.
ALC32 4)	いじンタン		AUD 16 MSEC FOR STATUS PACKET PROS.
,-	CALLE P. F. P.	, CONIL	JUMP TO CONTINUE.
ALS3E AD	しいつてき		ACO 27 MORE FOR PACKED XMASSION.
	SAINS FR.	UN1 C	JUAN TO CONTINUE.
ALL 32 a]	1021A		ADD ALL MEEC FOR PAUKET XHISSION.
	130 31	3	KELLASE TRUNK 3.7.
	14A 15F24		JUAP TO NODE NUNTON.
· · · · · · · · · · · · · · · · · · ·	(1	TO MUST GUB SHITTS BUILD	
•			
ALK11 QU	906.01	AL 011	ENTER OUTPUT OULUE FOR TRUNK 1,1.
i.v.	S31.7	ALIKI	SELZE THUNK 1,1 FOR SERVICE.
:: ::	- 1 - 1 - 1	:	DEFFRI COIPUL DUEUE.
	~ 1.1 (1	FN, ALSE1	XFEN DEPENDING UN PACKET LENGTH.
ALCII AD	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	10	ALU IL MOEC FUN STATUS PACKET PROC.
6. 117.18	11111111111111111111111111111111111111		ADAM TO CONTRACTOR CASONA CASONACA
	1 L 1 T 2	2 + 140	THE TOTAL SECTION OF THE AMENDE OF THE SECTION OF T
ALL 11 A D	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \		ADD 100 ANEG FOR PACKED MATRICIAN.
	100		
	12143F52	ANNY1	NEW CONTRACTOR OF SEAL
ALK21 PJ	31.16		ENIFR DUTFUL SULUE FOR 13UNK 2,2.
11.0	1.2.1		SELTE THUNK 2,2 FOR SERVICE.
.u		AL021	ULPAKT JUTFUT JUEUS.
	* ∃∃ ≒\ ∀	SE2	XFER DEPENDING ON PACKET LENGTH.
4LU21 AJ	BOYACE.		ADD 10 1350 FOR STAIDS PACKET PROC.
į	A 18 F 8	CONTR	JUMP TO CONTINUE.
AL>21 AJ	1107C		ADD 27 FOR O FUN PACKET XMISSION.
	というでき	9.1	COMP. TO COMPLICE.
	11 11 11 11 11 11 11 11 11 11 11 11 11		ALC BON HOUSE FOR PACKET MALSOLONS
3 :	1000		ARTHURON AND AND AND AND AND AND AND AND AND AN
	y :: 107 T	•	JOHN TO NUTE FINDERFLORE
ALK+1 0)	0.0 8.7 8	ALG".1	ENTER CUTFUT OUGUE FOR TRUNK 5.
מיי	1.7.	a L J K J	SELTE THUNK 4,5 FOR SERVICE.
20	7.1d	AL0.1	JERARI UUIPUT QUEUE.
	A 45 F.C. ?	FN,ALSE4.	XFER LEPENDING ON PACKET LENGIN.
ALC -T HI	いしクイフ	1 0	AND IL MOSEC FOR STATUS PACKET PROC.
	4 15 F E &	9 CUNT 9	JUNE TO COMPAGE.
PL341 1.7	23545	77	AUJ 27 ISEC FOR PACKET XMISSION.

	;	
かいしいアイグレ	SCONT &	CONTINUE
	2 T C	
ALP 41 1 34.15 F.E.	TNK43	CUAP TO NOOF TENKER.
AL 4.31 O.B. 18	AL 031	ENTER CITEDT DUEVE FOR TRUNK 3.5.
10 10 10 10 11 11 11 11 11 11 11 11 11 1	4 Y	SEIZE THERE S. E. FOR STRUTE.
1 V C (1)	AL031	DEPART OUTPUT QUEUE.
→ 24 31 FE →	FW94LSE3	XFES DEFENDING ON PACKET LENGTH.
ALUST ANVINCE	24	ADD 16 13EC FOR STATUS PACKET PROC.
	* CUNTA	JUMP TO CENTINGE.
ALSSE ADVANCE	27	ASS 27 13EG FOR PACKET XMASSION.
	, CUMIA	JUMP 10 CONTINUE.
ALL 31 ADVAKE	100	AND 1. C HEEC FOR PACKET XMISSIDA.
CURTA FELSESS	41180	KILLASE TYUNK 3,00.
ALB31 TRA 15FTR	, NUXI	JUMP TO MODE VERTON.
•		
•		
	:	
****	电子工作 医奎克氏管奎宁奎氏 医甲状腺 医多种性 医多种性	5.000.000.00.00.000.000.000.000.000.000
NEGUN 9 ROOM	SELVED BALCESSIVE CHES	6 Line - 2
ر.	CH CONTROL 4030	* S.32/TTdCd (MOS) S3
1501 :	LOGICAL TRANSMISSION LINKS	
	SHYSTOAL INMNSHISSION LINES	DN LINES (TRUNKS)
***** * * * * * * * * * * * * * * * * *	在在外,在外面,如此他一只知题小中非常的事情的。	
		COOK TO BY MANY TO MAN
THE CHANGE AND A COMMON TO A C	COSTRACA JASS	
VILLE WORK		2
>1:0405 X	J	AND THE PRINCIPLE WITH THE PARTY AND THE
7 (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	2.1	STORE IN FATA 2 THE PAIDRITY OF 1.
~ はんじてなり ~	CUN21	JUMP TO CENTAUL.
MICHE PALOCITY	~	MARK THIS FACKED WITH HIGH PRIORITY.
ASCESA	2,5	SID'L IN FANA 2 THE PAIDSITY OF 2.
U0.421 134.43FER	.62,,40%62	52% OF PACKETS ARE LONG.
ESS 102	3,1	SID-F ATT FRAN 3 THF LENGTH OF SHURT PKT (RITS)
TZAUSFEZ	, CON22	JUMP 10 CUNITAUL.
	5,6	SIDAL IN FARA 3 THE LENGTH OF LONG PKT(B115).
COLEZ MESTON	1. FNto EST?	ASS. GN L. (ESTINATION # (1 + 0) TO PARA 1.
TAB 15 FER	4 4 UY 1 , 1 NUY 2	SEAD HALF OF PKTS TO PROCESSORS #1 6 #2 RESP.
A TANA CONTRACTOR		TANALO E GOVERNMENT GENERAL MARKETA

ANDUI

ANDUI

ENTER INPUT QUEUE.

FH,PRIZI

KER DEPTUDING ON PRIGATY OF PACKET.

AND A HEG FOLLOW PRIGATY PROCESSING.

JUMP 10 GUNINUE.

STORE LESTELOW PRIGATY PROCESSING.

AND 3 MSG FOL FOL PRIGATY PROCESSING.

AND 3 MSG FOL FOLD PRIGATY PROCESSING.

AND 3 MSG FOL FOL FANKI, LINKS.

I 13,02AMO31,YL

STORE L-46TH OF TANKEN TRIKE.

INPUT QUEUE FOR SCH 1.

JE 13,02AMO31,YL

INPUT QUEUE FOR SCH 1.

JE 13,02AMO31,YL

INPUT QUEUE FOR SCH 1.

JE 13,02AMO31,YL

INPUT QUEUE FOR SCH 1.

JE 14,03AMO31,YL

INPUT QUEUE FOR SCH 1.

JE 15,02AMO31,YL

INP AUDYL - FUR SOM #1 AUTYZ - FOR SCM #2 * SUM PROCESSOR #1 13/4/EEC EECTES 53/4/5/EEC 53/2/0/ED 53/2/6/ED 53/2/6/ED 53/2/6/ED 53/2/6/ED LAVIVALUE LAVIVALUE SAVEUR HE PACATARA T SA 15FE & I SANDES & AUVANCE T. P. L. HELPU ANDY1 ODED! 5.1.28 H1F21 (L0P21

. SUM PROCESSOR AT

ENTER IMPUT OULUE.

SEIZE THE PROSESSUR FOR SEQVICE.

LEAVE IMPUT OULUE.

XFLY DEPENDING ON PRIDKITY OF PACKEL.

ALD & M.E. FULL LOW PRIDKITY PROCESSING.

JUMP TO GONIANUE.

ADD 3 MSED FOR LOW PRIDKITY PROCESSING.

RELEASE THE PROCESSOR.

\$15\text{SIDKE LEMSTH OF OLTRICK TRAKI, LINK2.}

\$15\text{SIDKE LEMSTH OF OLTRICK TRAKI, LINK2.} SIDAE LEISTH OF TINKER TEIKI, LINKA. SIDAE LEIGTH OF LINKEN IRAKA, LINKA. INANSFE' INUIN AD # TO PA LAPETER 5. 60 SELECT THE TRUNK. INDUT OFFUE FOR SCH 1. INPUT OFFUE FOR SCH 2. 1335 GENTAL INPUT OUR ANPKETTON POPENT PUT OUR 11,03AN031,XL 12,02AH341,XL 13,024KD+2,4L 132, 2. AHAJ1, X 10,028 MA 22, XL 9,0344021, XL 8 , 9. 4 NO11, XL FN,FKI22 , U0'12A ANGU2 Anf32 20014 ANPSZ SAVIVALUE SAVIVALUE SAVIVALUE SAVEVILLE LOPAZ KOVNOS TRANSFOR HIPZZ AOVANOS CUMZA KELEASE SAVIVALUL SUL WEVER SAVIUALUE T-44-12 F- 2 D-P11.T ANUYZ QJETE SELT

•	TRANSFER	FNskouiz	DEPENDING ON DESTN, XFER TO CUPRECT LIME.
	LINK 2 15 424 LINK 2 75 424 T.UTK 3 12 12 12 12 12 12 12 12 12 12 12 12 12	1 IS MAPE UP OF 1 TRJUK TO ALMANY. TRUNK A IS CONNECTED TO SCH 1. 2 TS MAME UP OF 2 TRUNKS TO F1.0ETRICK. TRUTK 7 IS CONNECTED TO SCH 2. FILHK 3 IS CONNECTED TO SCH 1. 3 IS MAME UP OF 1 TRUNK TO MANGOCK. TAUTK 1 IS CONNECTED TO SCH 2.	10 ALMANY. SCH 1. SCH 2. SCH 2. SCH 1. TO HANGOCK. SCH 2.
• • • •	L164 5 18 467 15044 7 15045 9	TE UP UF 2 TRUNKS IS CONNECTED TO IS CONNECTED TO	S 10 TINKEK. LON 1. SOM 2.
) ENMS		Р3,2, миист ҚТ1, не ғи, 1 мғиг	TFANSFEL IF STAIUS PACKET. TEBULATE THIS PACKET'S LOTAL DELAY. BASIO ON PACKET LENGTH, TRANSFER.
HMANNS HMANN HMANNS HMA		FN91MF52 FN91MF52 FN91MF12 KTM1L KTM1L	BASED ON PACKET PRIDRITY, TRANSFER, BASED ON PACKET PRIDRITY, TRANSFER, TABULAT PAI—SHORT PACKET DILAY. DE 1VER PACKET LUCALLY AND LEAVE NETWORK. 1490LAFF PRI—LONG PACKET DELAY. TABULAT LANG PACKET DILAY.
ANLUL UNDEZ	14841 14841 14844 12844	HATE ALT HATE HATE HATE HATE PAGESING FOR \$34.1.	DELIVER PACKET LOGALLY AND LEAVE NETWORK. TABULAT: NON-LOGG PACKET OFLAY. DELIVER PACKET LOGALLY AND LEAVE NETWORK. UNDELIVERABLE PACKET LEAMINATION.
* AUK 22 AUK 22	000007 SELUC DEPAYE TARASER ADVANCE CALOR	AND22 ANTK3 AHO22 FN, ANF22 16	ENICK OUTPUT QUEUE FOR TRUNK 2, 3. SEIZF TPUNK 2, 3 FOR SERVICE. DEPART OUTPUT QUEUE. XFEK DEPENDING ON PACKET LENGTH. ADD 11 MASC FOR STATUS PACKET PROC.
ANS 22 ANL 22 COM 24 AND 22	A US A CONTROL OF	3.00024 3.00024 3.00024 3.00024 3.70024	JUNY 10 CONTANTS. JUNY 27 NSEC FOR PACKEL XMISSION. JUNY 27 OCHTINUL. ACJ 111 ASEC FUN PACKET XMISSION. RELEASE TRUNK 2.3. JUNY 10 ASOC FI.DETKACK.
ANK41	0JEU8 SZ178 DEP441	ANO4.1 ANTKG ANO5.1	ENTER CUTFUL SUEUE FOR KRUNK **** SEIZE TRUNK *** FOR SERVICE** DEPART CULPUT QUEUE**

	7.00.17 61.0	175 V - NO	MESS DEPOSITOR OF DACKET LENGTH.
AH041	F 3V440"	10	AND 16 UNEU FOR STATUS PACKET PROC.
	1 (A-45) P.C.R.	, cover	LUATE TO CONTENT .
ANSAL	A DVANCE.	2.7	AUD 27 MALC FOR PACKET XMISSION.
	1 CH.L.F.	, CUNZ	JUMP 10 CONTINUE.
4.46.1		1.0	ATO 11'L MSEU FUN PACKET MILISIUM.
50.42		A1114.	
Artes +1	1 4A45 FF4	1 NY 1.2	
•			
ANK 11	3).1):	ANDII	ENIEN COLFUI GULUE FOR IKUNK 1950
	55175		SEIZE THINK 1,5 FOR SERVICE.
	1:50	ANGII	DEPART JUIPUT JULUE.
	1.44 US FE ?		XFES DEPENDING ON PACKET LENGIN.
ANC 11	A DVANCE		AUD 16 MSEC FOR STATUS PACKET PROC.
	1421514	JASE	JUAR TO SONTINUL.
ANDIL	トロスキ入りな		ADD 27 HSEC FOR PACKET XMLSSION.
	1 (410: 52)	, CUNZo	JUAF TO CONTINUE.
APR 11	AUVANCE	100	ACO 116 MSEC FOR PACKET X 115SION.
CON 20	15 11 TEN	A:11K5	
AND 11	T th IPFER	, ALBN2	JUMP 10 HODE ALBANY.
รั	UNIPUE PROGES	SING FOR SOM 2.	
ANK31	0.JEHF	ANGSI	ENIER OUTPUT QUEUE FOR TRUNK 3,1.
	SC126	ANTKI	SILZE 1, UNK 3.1 FOR SERVICE.
	(1.5.P. L.C.	ниост	DESART AUTRUL SULUE.
	1 CA 12 F3 4	FN, MASES	XFER DEPENDANG ON PACKET LENGTH.
ANC31	MIDVAVOE	10	ADD 16 HISEC FOR STATUS PACKET PROC.
	1 24 15 F.28	* CUN23	JUMF 10 SENITABL.
ANJ 31	FONVACE	21	ALD 27 HSEC FOR PACKEL XMLSSIUN.
	1 4.5 TS F B.3	,00027	JUMP TO COMPINDE.
D.M. 31	ADVIVE	300	AUD 161 4SEC FOR PACKET X415S10M.
CU.Y.	ES 12 19 1	ANTKI	RILLASE FIUNK 3,1.
ANU 31	144 45 FES	NO NAME &	
-			
ANNEL	0.70	TOPIN	CALCA COLFO COROR FOR TAXA CACA
	. T.S	ANIKA	SELVE LUNK BAR FUR SERVICE.
	17.14.0		DEPART COLFUI MCDE.
	1 24.15 F.78	F14,4NSE2	XFEN DEPENDING ON PACKET LENGTH.
ANC 21	A 34740 F	: :	ACO 16 MSEC FOR STATUS PACKET PRUS.
	T < A 1: F E &	, CO428	COSE TO CONTROLS
A14.5 21	F024204	21 .	ATD 21 NSEC FOR PACKET XMISSIOM.
	1 45 45 F.C.P.	, CUNZo	JUNE TO CONTINUL.
44L 21	1) V 1 V C	10.1	ADD 11L MSEC FO. PACKET XMILS10M.
CO; 2,	10 10 10 10 W	AH] K2	KELEASE THUNK 2.2.

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1% OF PACKETS ARE HIGH PRIORITY.

DENOTE FT.DLISION AS SUUGE NODE, ID=3.

MARK THIS PACKET WITH LOW PRIORITY.

SIDNE IN SAMA 2 THE PRIORITY OF 1.

JUMP TO CONLAND.

MARK THIS PACKET WITH HIGH FRIURITY.

SIDNE II. FAMA 2 THE PRIUMITY OF 2.

C2% OF PACKETS ARE LUNG.

SIDNE IG. FAMA 3 THE LENGTH OF LUNG FKT(RITS).

JUMP TO SCHINUE.

SIDNE IN FAMA 3 THE LENGTH OF LUNG FKT(RITS).
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        323, FHALK POH, , , , F GEN. PACKEIS & 24% SAT. - MEAN OF 323 MSEC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ASSIGN A DESTINATION # (1 - 8) TO PARA 1. SEVU CHE THIRD OF PACKETS TO PROCESSOR #3.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             SENU THIRD TO PROCESSURS #1 AND #2 FLSU.
                                                                                               XFEN DEPENDING ON PACKET LENGTH. 400 10 MYFG FOR STAINS PACKET PROC.
                                    ENTER OUTPUT DUEUE FOR TRUNK +,5. SELZE THUNK +,5 FOR SCRVACE.

DEPART CUIPUT QUEUE.
                                                                                                                                                                        JUME TO CONTINUE.
ADD ICC 48EC FOR PACKET X4IDSION.
                                                                                                                                    JUMP TO CONTINUE.
ALD 27 MSEC FUR PACKEL XHISSION.
 JUMP TO NODE FT. DETKICK.
                                                                                                                                                                                                                                                                                                                                 路上的路上,一切,中心时间,这中部,我们们,看到你们的秘笈是中国的中华中国,是一个人的人的,也也没有严重,我们
                                                                                                                                                                                                                                                                                                                                                                                       3 SWITCH CONTROL MUDDLES (SCM) PUPII//0°S * LOGICAL TRAMSMISSION LINKS * 12 PHYSJUAL TRANSMISSION LINES (FRUNKS) *
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   南山东北南山西西州人南南州,南北南州西北南南南南河。 1000年,中华山南南东南
                                                                                                                                                                                                              MELLASE TAUNK 4,55.
JUMP TO 4305 TINKER.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ** NaTWORK PECKETS ENDER THE FT.DETRICK NOSE AT POINTS
** FELSE + FOR SOM #1.
** FIDES + FOR SOM #2.
                                                                                                                                                                                                                                                                                                                                                                       HUJE FT. JFT! ICK PROCESSI 45 CENIER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                .>,FIDE1,*TJE2
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ATEKKS
FTDE3
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ANG: 2
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A3S USH .
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AND+2 TRA ISFER
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SELTE
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DEPENDING ON CESTA, XFER TO COARECT LINK. JUMP TO CONTINUE. ADD 3 H ED FOR HIGH PRIORITY PROSESSING. RELEASE THE PROVESSOR. XFER DEPENDING ON PHILHRIY.
ADD F MSED FUN LUW PHIDNITY PROCESSING.
JUMP TO GUNITHUE.
ADD 3 MSEC FOR MIGH PRIDMITY PROCESSING.
RELEASE THE PROLEUSUM. 144,020E013;X. IYPUT PIEJE FOR SCH 3. DEPKRIPPLFZ;P3;P1;P1;PP GO SELECT THE TRUNK. 9,XF3 XFE DEPENDING ON PRICKITY.
ACT & HARE FOR LOW PRICKITY PROCESSING. SIDNE LENGTH DE ALBANY TRIKI, LINKI. SID-E LEIGTH DE ALBANY PRIKZ, LÍNKI. SID-E LENGIH DE ALBANY PRIKZ, LÍNKI. SID-E LENGIH DE ANDREWS TRNKI, LÍNKZ. SID-E LEGGTH DE ANDREWS TINKZ, LÍNKZ. STORE LINGTH OF GENTILE TRNK1, LINK?
S10% LINGTH OF GENTILE TINK2, LINK3.
STORE LINGTH OF GENTILE TRNK3, LINK?
STORE LINSTH OF HANGOOK TANK1, LINK.
STORE LINGTH OF HANGOOK TANK1, LINK. STORE LEMSTH OF ALBARY TRAKE, LINKE, STORE LEMSTH OF ALBARY TRAKE, LINKE, STORE LEMSTH OF ALBARY TRAKE, LINKE, STORE LEMSTH OF AHOREMS TRAKE, LINKE, TAGEN OF TANKER INAKE, LINKS. TISTH OF TINKER TRAKE, LINKS. ENTER SUM 2'S IMPUT QUEUF. SEIZE THE FNOCESSUM FOR SERVICE. DEPART IMPUT GULUE. ENTER SCH 1'S INPUT QUEUE. DEIZE 1ME PRODESSOR FUR SERVICE. DEPART INPUT OULUE. STORE L'IGTH OF TINKEN INPUT QUEUE FOX SOM I. IKPUT OILUE FOX SOM 2. 313.E L 143,040_0J2,44 144,040£0J3,4 10,020E012,XL 10,020E013,XL 17,020E021,XL 142,0;0i0111,X. 10,0.0E922,X-19,0000031,XL 20,000 US US 172, XL 24,00 DEADLOX. 25,920E032, YL 14,901 DEQ119,XL 19,050E012,XL 10,0.05013,XL 17,0305021,XL 21,040c333,XL JX 6 140 JOIN 0 422 23,020c0,2,XL 14,030E011,X FN, LOUT 3 FN,PKI 31 FN,F4132 , CUN33 CUN34 5 3 X 6 5 0.EQU2 0.EQU2 0.EQU2 0EP31 DEPS1 DEP.2 DEOU1 , J THE PLUCESSON WITH SAVIVALUE SAVIVALUE SAVIVALUE SAVEVALUE 54V EVAL UE 54V EVAL UE 54V EVAL UE 54V:VALJE 54V:V4,0E SAVEVILUE SAVEVE JE SAVEVALUE FRANSFER HIP32 ADVANCE CON34 REL 2012 SAVEVALUE SAVEVALUE TRANSFER ADVANCE 1 ta IDEGR ADVANCE SAVEVALLE SAVIONINE 31. 47. 740 SAVIVALUE SAVIVELIJE * SCM PROCESSOR TAMIFFER LOP32 ADVANCE T KALAS FERR 327.778 DEP.13.1 D.F. A. A. FTJEZ QJEGE SELTE FILET OUCUE HELOT H1F 51 CU-133 LOF 31

FT353 - FUK SOM #3.

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DEPENDING UN DESTN, KFEN 10 CONFECT LINK.
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ALU E MSGC FOR LOW PRICALTY PROCESSING.

JUNY TO CONTINUE.

AFO 3 M LO FOR HIGH PRICALTY PROCESSING.

RELEASE THE PRUCESSUR.
SIDAE LLASTH OF GENTLE TRAKE, LINKS.
SIDAE LAGTH OF GENTLE TRAKE, LINKS.
SIDAE LENGTH OF GENTLE TRAKE, LINKS.
SIDAE LENGTH OF HANCOCK TAKE, LINKS.
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SIDAE LAGTH OF TINKE SIDAM, LINKS.
SIDAE LAGTH OF TINKE SIDAM, LINKS.
INPUT OUGUE FOX SCHIL.
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SIDSE LINGTH OF ALBANY TRAK2, LINK1.
SIDSE LINGTH OF ALBANY TRAK3, LINK1.
SIDSE LINGTH OF ANDREWS TRAK3, LINK2.
SIDSE LUNGTH OF ANDREWS TRAK3, LINK2.
SIDSE LUNGTH OF GENTLE TRAK1, LINK3.
SIDSE LENGTH OF GENTLE TRAK3, LINK3.
SIDSE LENGTH OF GENTLE TRAK3, LINK3.
SIDSE LENGTH OF HANCOCK TRAK3, LINK4.
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5,XF3
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STONE LENGTH OF TINKER TRAKE, LINKO.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ENTER SOM 3'S INPUT QUEUE.
SEIZE THE FNOCESSUR FOR SERVICE.
DEPART THRUT QUEUE.
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INPUT CHEUE FOR SOM 2.
INPUT CHEUE FOR SOM 3.
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  199 030 E031, XL
21, 02 0 L 0 33, XL
22, 01 0 L 0 41, XL
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13,020E031,KL
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LANK I IS MADE UP OF 3 TRUNK TO ALPARY.

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DELIVER PAUKET LOGALLY AND LEAVE NETHORK.
143ULNT NON-FAL SHOKE PACKET DELY.
UELIVEP PACKET LOCALLY AND LEAVE NETHORK.
163ULNT NON-PAL LONG PACKET DELAY.
UELIVER PACKET LOCALLY AND LEAVE NETHORK.
                                                                                                                                                                                                                                                                                                                                    BASED OF PACKET LENGTH, TRANSFER,
9ASED OF PACKET PRIDKITY, TRANSFER,
8ASED ON FACKET PRIDKITY, TRANSFER
TABULALF PRI-SHORT PACKET DILLAY.
DELIVER PACKET LUGALLY AND LEAVE NETHURK.
                                                                                                                                                                                                                                                                                                      TRANSFEN IF STATUS PACKET.
IRBULATE THIS PACKET'S TOTAL DELAY.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           XFEN, PEFENDING ON PACKED LENGTH.
ADD 11 "SEC FUR STATUS PACKED PROG.
JUMF TO CONTINUE.
AEG 27 ISEC FOR PACKED XMSISSION.
JUMP TO CONTINUE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 UNDELIVERABLE PACKET TERMINALION.
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RELLASE TFUNK 2,2.
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4 13 HAFE UP OF 2 TAUNKS TO HANGOOK.
TAUNK 12 15 COMMEDITO TO 52H 2.
11 TS AME UP OF 3 TOUNKS TO TINES.
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THINK 5 15 COMMEDITO TO SOH 1.
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0EL 13			ENTER DUTPUT DUEUE FOR TRUNK 1,5.
	36.130		SEIZE THUNK 1,5 FOR SERVICE.
	J.KG-C	Denis	DEPART JUTPUT QUEUE.
	1-4 NJF -	*	XFEX DEPENDING ON PROKET LENGTH.
54030			ACO 16 1850 FOR STATUS PACKET PROD.
	3 4A115 F.74	,500%	JUMP 10 DOWLINGS
L3H13			ADD 21 1940 FOR PACKET XMASSIUN.
	4 CH 12 E C	<u> </u>	JUMP TO SCRIINOR.
PL 0.13	にしシャクにゃ	410	APD 101 45EU FOR PACKET X 415SLO4.
60.137	-		KILLESE TRUIK 1.0.
06.713	1 th 15 FE &	, ALBN1	JUMP TO NUDE ALBANY.
•			
Det 5.2	C	06912	EPTER OUTPUI QUEUE FOR TRUNK 4,7.
	5517	0147	SEIZE INJUK NOT FUR SERVICE.
	Pibar	55475	DIPART MIPUT QUEUE.
	~	F14,02F52	XFEN DEPENDING ON PACKET LENGIH.
たいこり	A JVAVCE	1 c	ADD 15 RISEC FOR STATUS PACKET PROC.
	1 CA.42 F.94	• CONSO	JUMP IC CONTINUE.
SH52	1) N ! N [r	,;;	ADD 27 HOLD FOR PACKET XMISSION.
	T \$ M.45 FC &	• CUNSE	DUNITABLE.
26.970	A DVAVIDE	1,00	ADD 1.6 4SEC FOR PACKET XMISSION.
CO+30	NELET IT	בי	20%
DELOS	T tarts F 2.8	, INKR1	JUMP TO NODE TINKER.
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J:L 31	1010	01.03	THIS DOUGHOUS DEFINE THE STREET
•		0.00	DELICATIONS OF THE SERVICE.
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3 ••	30(54 TU-TU0	PANCETSING FOR 324 2.	•
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DEL 12	nJen:	UL012	ENTER OUTPUT QUEUE FOR TRUNK 1,4.
	1 1 1 2	DIK	SE17E THUNK 1,4 FOR SERVICE.
		DEQ12	DESART AUTPUT QUEUE.
	144 1: FE ?	FN,0ES12	Ξ.
0EC15	いいつかんしょ	16 	ALIO 10 1000 FUN STATUS PACKET PROC.
	1 4A.45 F.C.	* CONGA	JUMP TO SUMITABLE

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	, e	SEC FOR TRUTE
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15.1 5.1 0.31 135	.) e 0. 1	ENTER DUI DUT DUEUE FOR IRUNK 2000
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ペール (T. 女子) L	SEL	KEL LENG
DECUT ADVANCE	1	APU 16 MOTO FOR STAIDS PACKET PROC.
	3B NO.	
DSHST ADVANCE	27	AND 27 MSEC FOR PACKET XMISSION.
	, ೧೮೪೫೫	JUMP 10 CONTINUE.
PLUST ADVISOR	ن، ١	ADJ 10/ 458U FOR PACKET XHISS104.
	UTK	ELLASE FRUNK Jyb.
DEIDT TAN ISPER	, TNXX2	JUNE TO HODE TIRKER.
DEC 32 03EJ:	01432	BELIEV BUILDIUDIUE FOR IKUNK 50.00
1112		CAT AND THOUGH SHAND SHANDS TO THE SHANDS TH
LINE TO THE TOTAL	0.5032	DEPART COLFUI JULUE.
そり国のでは、こ		XFEX DEPENDING ON PACKET LENGTH.
DED32 ADVANCE		ADD 16 WARD FOR STATUS PACKET PROC.
CHICKY I		JUAP TO CONTINUL.
DSH32 ADVAVOR		ADD 27 ISEC FUR PACKEL XMISSION.
T CAUTER?		-
٠.	100	
30 12 12 1 28 201	01.60	RELIANCE TRUIK 3.9.
-) PCN C	2
retunt adens		ENTER DUIFUT DULUE FOR TRUNK 1,11.
	OTK11	SERVICE.
TSP.14T		DEPART JUTHUT QUEUS.
1 44 15 177	541	XFEX DEFENDING ON PACKET LENGTH.
DEC41 ANVANCE		ADD 10 1SEC FOR STATUS PACKET PROC.
	, covs	JUMP TO CONTINUE.
DSH41 ADVAVOL	2.2	
	covan	4F TO CONSINCE.
	111	1.0 MSEC +
COA33 KILIMOS	01K11	LASE TRUNK +,111.
	* HANCK	01 41
• OUTPUT PAUCE.	SING FOR 304 3.	
16:21:01:5	10040	AND AND STREET AND STREET AND
;	121	2000

000000	UTK1 UE921	SEIZE TPUNK 2,1 FOR SEKVIDE. OF DART CUTFUT JUEUE.
1 44 15 FER	FN, 0E i 21	XFEL DEPLIDING ON PACKET LENGTH.
LEGST ADVINCE	10	AUD 16 45ED FOR STATUS PACKET PROC.
	3 C C C 3 C	JUME TO CONTINUE.
DEMEST ADVANCE	7.7	ADD 27 MSEC FOIL PACKET XMSISSLON.
	• CONSE	- HDATHA
DEG 21 ADVANCE	1 ; C	ADD 11M 45EL FUN PACKET X415SION.
	1710	RELEASE TRUNK 2.1.
PE 124 T 45/12 F 12	, ANDY 2	JUMP TO YOUR ANDREMS.
		We will have a second of the s
11.000	0 5 (11)	CONTRA COLVO TOTON TOT INTO THE SECOND SECON
14 G	2,017	DESCRIPTIONS IN FOR DERVIOE
で 日 しょうこう か		CONTRACT COUNTY TO COMP.
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CONTRACTIONS	16	MIND TO COMPUTE STATES PACKET PROC.
	F 0 5 0 5 0	
ALLANCE TITAL	6.1	ALC AN ANNE FOR FACKE MALVALUM
\$ 0.407 KY L	• CONSE	CONTINUE.
FLG11 ADVANCE	10.6	ALD THE MUTE FOR PACKET XAISSION.
CONST FALST FE	Ę¥3	ところ
DE111 14445FER	, ALBN 2	
	270	A C AMERICA CONTRACTOR CONTRACTOR CONTRACTOR
DELSS MUTUE	DEUSS	101100
-	0 K15	SELVE TOUCH SOIL FOR SERVICE.
176450		THE PART TO LEGISTRATE OF THE PART OF THE
	F14,012,133	
UEC 33 A JVAKOF	16	AUD 16 ASEC FUR STATUS PACKET PROC.
	, Co436	JUMP 10 CONTINUS
DSH33 AJVAKGE	21	AUD 27 ASEC FUR PACKET XMISSION.
T 4A 15 F E R	, CON36	OCM INC.
CLG33 ADVAVOR	1.1	AFD 110 45EC FOR PACKET KAISSION.
C043G R2L245Z	DIKIO	TRUNK 3,13
DE133 144-1564	, GEN! 2	7
,		
DEF-42 GUEUL		ENTER COTPUT COLUE FOR TRUNK 12.
55175	01412	SEI7E THUNK HOLD FOR SERVICE.
トングルコン		DEPART JULBUT DUEUF.
7 44 43 FER	٠,	XFEN DEFINDING OR PACKET LENGTH.
DECAR ADVANCE		ADD AR MSEC FOR STATUS PACKLT PROC.
1 8x 45 FER		JUMP TO SCHIINDE.
DSM42 ADVAVOE		ADD 27 MSED FOR PACKET XMISSIUM.
を見るかな】	, CON34	JUAP 10 GONIINJE.
DLG42 ADVIAGE	110	AED 1' W MELL FOR PACKET X11 SSION.
CONSH PELLESS		RELEASE TRUNK ++12.

JUMP TO CONTROL.

MARK THES PACKET MITH HIGH PRIORITY.

\$10mt IN FARA 2 THE PALORITY OF 2.

67% OF PACKETS ARE LUNG.

\$10mt TO CONTROL.

\$10mt TO CONTROL.

\$10mt TO CONTROL.

\$10mt TO PACK 3 THE LENGTH OF LONG PRICRITS).

ASSIGN A DISTINATION # (1 - 6) TO PARA 1.

\$10mt OF PRIS TO PROCESSONS #1 % #2 RESP. bijFN.EXPDN,,,,F GEN. PACKETS & 20% SAT. - MEAN OF 51 MSEC .ul,,HIGH. 1% OF PACKETS AND HIGH PALOALTY. .ul,,HIGH. DENOTE GENTILE AS SUURCE MODF, ID=.. XFE- DEPENDING ON PAIDRITY.
ADD 5 MAGD FOR LOW PAIDAITY PROCESSING.
JUMP TO CONTINUE.
ADD 3 MAEC FON 4164 PRIOAITY PAOSESSING.
RELAKE THE PAUCESSOM.
SIONE LANGIH OF UETRICK TANKI, LINKI.
SIONE LANGIH OF UETRICK TANKI, LINKI. MARK THIS FACKED WITH LOW PRIDRITY.
STOPE IN PANA 2 THE PRIDRITY OF 1. ENTER SCH 1'S INPUT OUEUE. SEIZE THE PROCESSUM FOR SERVICE., DEPART TYPUT OULUE. "各种的操作银管通过有种的资格系统,即为中心的特殊,为此信息与的联系中央专的特殊的一段的文化。" 医白格特氏手术 "我是你 JUMP TO NODE HANCOCK. NOME SEMITLE PROCESSING SENTER
E SMITCH CONTROL MOJULES (SCM) POPIL/70*S
E LOGICAL TRANSMISSION LINKS
E PAYS: CAL TRANSMISSION LINES (TRUNKS) C PROKETS ENTER THE SETTILE ACCENT PULNESS CANTLL - FUN SOM #1. GEVIL - FON SOM #1. ************************* . 5.56 N11,3 FHT2 20,036EQ11,XL 27,046EQ12,XL 1,FN:UEST. .62,,LONG. FN,FK141 , HANCK SCUN41 CON42 \$ CON+3 GEOU1 GEPS1 6 = 001 GEHS1 2,2 = METWORK PROKETS GENTI GENEVATES GENT TRANSFER ASSISP SAVEVALUE PAIGSTAY ASSIBU T KANSPER ASSEGN DET42 TRAUSFER SCM PROCESSOR TAM ASPER F 21.05 1.1 Y 1 3 P 11 S F 5 3 4 ELET. 54 1 1 24 11 FLR THANSFER 438230 438530 HIDAL ADVAKED TOURS TOURS AT THESE STATES AT THE SECOND TO ASSIC. DEPART GENTA OUETA SELZE HEGH 141103 10.01 24200

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JE 29, GGEGLI, KL. SID-E LENSTH DE DETRIOK JANKI, LINKI.

JE 29, GGEGRI, KL. SID-E LENGTH DE HANCOCK TANKI, LINKZ.

JE 31,04,6E071, KL. SID-E LENGTH DE HOCLELLAN TANKI, LINKI.

JE 32,04,6E071, KL. SID-E LENGTH DE HOCLELLAN TANKI, LINKI.

JE 33,04,6E071, KL. SID-E LENGTH DE NOCION TANKI, LINKI.

JE 34,04,6E071, KL. SID-E LENGTH DE JANES, TANKI, LINKI.

JE 123,04,6E071, KL. INPUT QUEUE FOX SCM.

JE 123,04,6E071, KL. INPUT QUEUE FOX SCM.

GEPKRI, PI, P2, P3, P2, P2, P2, GO SELECT THE TRUNK.

JANES.

JANES.

JEANSFER THE LAUKTER S.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 SIDRE LEAGTH OF DETAILS TANKL, LINKI.
SIDRE LEAGTH OF DETRICK TANKS, LINKI.
SIDRE LEAGTH OF DETRICK TANKS, LINKI.
SIDRE LEAGTH OF DETAILS TANKS, LINKI.
SIDRE LEAGTH OF HOLIELLAN TANKI, LINKI.
SIDRE LEAGTH OF HOLIELLAN TANKS, LINKI.
SIDRE LEAGTH OF HOLIELLAN TANKS, LINKI.
SIDRE LEAGTH OF TANKER TRAKI, LINKS.
LINRUT OUTUR FOR SCHILL
LINRUT OUTUR FOR SCHIL.
LINRUT OUTUR FOR SCHIL.
LINRUT OUTUR FOR SCHIL.
                                                                                                                                                                                                                            DEPENDING ON DESTIN, KFER TO CURRECT LINK.
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                                                                                                                                                                                                                                                                                                                                                 DEFMA: IMPUT DUTUE.
XFER DEPENDING UN PRIDRITY.
ACC 5 MSEC FOR LOW FRIORITY PROCESSING.
JUMP TO CONTINUE.
ACC 3 MREC FOR HIGH PRICKITY PROCESSING.
ACC 3 MREC FOR HIGH PRICKITY PROCESSING.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              THANSER, THE TEDAK TO # TO PARAMETEN 5.
                                                                                                                                                                                                                                                                                                           ENTER SOM 215 INPUT OUEUE.
SELZE THE PROCESSOR FOR SERVICE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           LINK I IS MAPE UP OF A IRJUKS 10 FT.DELRICK.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             TAURK F 15 COMMEDIES 10 SCH 1.
FRUNK F 15 SUMMEDIES 10 SCH 2.
FRUNK F 15 CONNECTES 10 SCH 2.
2 IS MANE UP OF 1 TRUNK TO HANGOGK.
TAURK M IS COMMEDIES 10 SCH 2.
3 13 MANE UP OF 2 TRUNKS 13 MCCLELAN.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   04,05,0E032,KL STOKE LF
152,05,0E011,KL INPUT OH
153,02,0E012,KL INPUT OU
5EPKKT;P1,P2,P3,P ,FJ,P
                                                                                                                                                                                                                                                                                                                                                                                                                                                                       20,0066011,XL
27,0066012,XL
20,0066013,XL
29,0066021,XL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              32,0,6c341,Xt35,0c6031,Xt
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       3u,016c071,X-
31,026c032,Xc
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6 c Ps 2
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HSSLER
TAKUSFER
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COMMA NELTOS
                                                                                                                                                                                                                                                                                                                                                                                              LOP42 - JVAVCE
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TARCLATE THIS PACKET'S TOTAL DELAY.
BASES ON PACKET LENGTH, TANSFER.
BASED ON FACKET PLICALTY, TANSFER.
BASED OF FACKET PLICALTY, TANSFER.
TABULET PACKET PLICALTY, TANSFER.
TABULET PACKET LUCALLY AND LEAVE NETHORY.
THRUBT PRI-LONG PACKET DELAY.
DILLYKK PACKET LUCALLY AND LEAVE NETHORK. TABULATE HON-PAI LONG PACKET DELAY. DELIVER PACKET LOCALLY AND LEAVE NETWORK. UNDELIVERABLE PACKET TENMINATION. IABULATI NUN-PRI LHUNI PACKET DILAY. Diliyen Prokfi Locally fnu lenye neuhokk. ENERA OUTFUL OULUE FON TRANK 5.1.
SELZE TEUNK 5.4 FOR SCRVICE.
DEPART HUIFUL RULUE.
XFE - DEPENDINS ON PRUKEL LENGTH.
ALD 16 HSEC FOR STATUS PACKET PROC. AUD 11 MSEC FOR STATUS PACKET PROC. ENTER DUTOUT JULUE FOR TRUNK 3,1.
SELTE LUNK 3,1 FOR SERVIDE.
DEPART CUTOUT DUEUE.
XFEL, DEPENDING ON PACKET LENGTH. APD 116 MSEC FUR PACKET X 11351AN. RELEASE TAUMY 3.1.
JUMP TO NODE MCCLELLAN. JUMP TO CUNTINUE. ADJ 27 MAEG FOR PACKET XMISAIDN. ADD 27 MSEC FUR PACKET XMISSION. JUMP TO CUNITNUE. IF STATUS PACKET, THANSFER. JUNE TO CONTINUE. JUAR TO SOMTINUE. TYDUK I IS DUNNEGIED 10 SCH 1.
TYDIK 2 LS CONNEGIED 10 SCH 2.
TYDIK 3 IS CONNEGIED 10 SCH 2.
LINK 3 A4FE UP 0F 2 TAJNKS 10 ILNES.
TYDIK 4 IS DUNNEGIED 10 SCH 1.
TYDIK 4 IS CONNEGIED 10 SCH 2. OUTPUT PROCESSING FOR SOM 1. P3,2, GEMEL FR,TAFUL FN,TAPUL FN,TAFUL FN, GEF31 FIN, SEF51 7+202 MCDL 1 CONT. Saron, S CORTO X 1 1 4 5 GE031 GLTK1 STHIN Se 2:1 KILUS GETKL GE JK+ A) HIL RTLOL #:019 GE 931 1 14491 415 1441 623 1844 623 1855 788 4567 18064 788 3568 66845 143 143 En to that a CN 41 HATE En to hard 1 th 15FE t UNJEW TENTERATE CELUS 1439LATS GEL 0L 1430, ATE TANSFER GEUST ADVANCE 1 24 JEER 63H31 A JVAVE CEN31 1 44 45 FC 8 1 ANYSFER GEUDI ADVANCE) Cartering GEHIL INBULLE 1 th 40 FE GLEST ADVAGE 0.P1%T U.PARTO GEL ST. OUTUE SETZE GEL 31 0 JE 15 63:451

GLGDI ADVANCE COMO FILETSE	150 GETK4	ATO 189 MSEC FOW PACKET XMISSION. RELEASE THOUR 3,4.
1 &M 45 F	_	JUMP 10 NODE TANKER.
GEL11 GJLUS S.2X*F		ENTER DUTPUT DUEUE FOR TRUNK 1,6. SUIZE 174MK 1,5 FOR SERVICE. GEDAGE MILEN DUEUE.
	, GEF11	KERN TERENOTING ON PROKET LENGTH.
	7.500.00	JULY TO CONTINUE.
124 12 12 12 13 13 13 13 13 13 13 13 13 13 13 13 13		ADD 27 1850 FOR PACKET XMISSION. JUNE TO CONTINUE.
		APP 161 15EC FUR PACKET X11 38104.
CONTRACTORSE	GL1Ku ,FTDE1	RELEASE THUNK 190. JUNE TO 4005 FIRDETRIOK.
		The MINE SOR TO THE THE AND
		SLIZE T. UNK 4, 3 FON SCHVIGE.
DEPACE		Dracal Hijpul Queuc.
I & ISFF?	F 12, 61.34.1	AFE' DEFENDANC OR PACKET LEDGING AFD AL ASEC FOR STATUS PACKET PAGG.
TANSEGA GSHAT A DAAGE	ጋን ደፍ ይ	JUMP TO CONTINUE.
		JUMP 10 CONTINUE.
6LUH1 40V4407		APD 123 4SEC FUR PACKET X413SION.
GONDO NELOGOL GENHA TRANSFER	E: K3 2071	ALELANE TAUMA ++3+ JUNP 10 MODE NOATOM+
UNTPUT FROCE	SSING FUR SCH 2.	
GE'L 32		ENTER OUTPUT QUEUE FOR TRUNK 3.2.
しことろこり		DEPART BUTPUL GUEUE.
そにはいて マント こうじゅうしょく こうしょう しょうしょう しゅうしゅう	FN,6ES32	XFER DEFENDING ON PACKET LENGIN. ALO 16 MSEC FOR STATUS PACKET PROC.
	•	
GSH32 AJVIVE		ADD 27 ASEC FOR PACKET XMISSION.
516.32 ADVANCE		JOHN TO CEMILANDE.
		KELLASE TRUNK 3,2.
621132 1 (m 13 Fc)	~	JUMP TO AUDE MODERLAN.
GELD2 QJETE	5 6 0 3 5	ENTER DUTPUT QUEUE FOR TRUNK 255
55.45	GETKO	SELTE TOUR UPS FOR SERVICE.
05PA: T	6 E Q 5 2	DIPART JULPUL ANGUE.

TANSFER GECUS EDVAKOS TANNSFER GSHSS EDVAKOS	FN, 6ES52 16 9 COU4A 27	XFEW LEPENDING ON PACKET LENGTH. ADD 15 MSEC FOR STATUS PACKET PROC. JUHF 10 CCNTLNUL. AGD 27 MSEC FOR PACKET MILSTON.
F 1 € 2 €	A CONTA	JUNE 10 CONTINUE.
60000 404400 60144 ALLEAGE 66152 14448762	4 THK3	AFLESS TAUM G.S.
62112 77505 5517:	6£012 6£TK?	ENTER DUTFUL QUEUE FUR TRUNK 1,7. SEL7E TOUK 1,7 FOR SERVICE.
1 2 4 4 5 1 5 1 5 1 5 1 5 1 5 1 5 1 5 1 5 1	6E012 FN•SES12	DEFART OUTPUT QUEUE. XFE. DEPENDING ON PACKET LENGIH.
GEC12 ADVANCE	1	AGO IN ASEC FUR STATUS PACKET PROC. JUNE 10 CONTINUE.
6SH12 AUVA (05)	27 • CUN4 B	ADD 27 MSEC FOR PACKEL XM.SSION. JUMP 10 CONTINUL.
GLS12 ADVAVO	, H.	ADD THE MSEL FOR PACKET XMISSION.
CENTZ FARTSFER	, F.10E2	10 4 10 10 10 10 10 10 10 10 10 10 10 10 10
62113 0JU J.	6EQ13	ENITS OUTFUL DUIDE FOR TRUNK 1,9.
TERRIT	•	DEPART OUTPUT GULUE.
CELLS HIVANCE	7 14 5 E 5 1 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	ADD 16 YEE FOR STAIUS PACKET PROC.
TIA PERS	27 27 27 27	JUNE TO CONTINUE. AND 27 1950 FOR PACKET XMISSION.
1 (AVETER 1) VACE EX	3 COX 6 C	
CONHU KALIRSI GEN13 14A-13FEK	GLTK8 • FTUL3	AFLEASE TAUNK 1,0. JUMP TO NODE FINDETFICK.
6Et 23, 0.15"));	68021	ENITE CUTFUL BULUE FOR TRUNK 2,3.
l I	6 r 7 K9	SCIZE TIUNK 2, FOR SERVICE.
1 45 15 77 3	6 5 4 7 1 F N, GES 2 1	AFE. DEPENDANS ON PACKET LENGTH.
6±021 A)V \\C.	10	AGO 10 TOLIC FOR STATUS PACKLT PROC.
1 KM JUNE C 6SHZ1 ADVAVOL	, CO34 D 27	ACT TO SERVICE FULL PACKET XMISSION.
	d +1300 4	JUMP TO GOWILMUE.
	доц	ATO 1.0 MSEC FOR PACKET XHISSION.
こうべきの からに ひょう	5 K J	THE COURSE TO LOCAL THE CASE
	4) ZT L 6	100

12 UF PACKETS A 20% SATA - HEAN DF 97 MSEC 12 UF PACKETS ARE HIGH PRIORITY.
DENUTE HANGUCK AS SUNGE NODE: ID=5.
HANK THIS PACKET WITH LUW PRIORITY.
SIDNE IN PAKA 2 THE PRIURITY OF 1.
JUNY TO PAKA 2 THE PRIORITY OF 1.
MASK THES PACKET WITH HIGH PRIORITY.
SIDNE IN PAKA 2 THE PAIDWITY OF 2.
BEY OF PACKETS ARE LUMG. SIDAE IN PANA 3 THE LENGTH OF SHOKT PKT(BITS). STOLE IN PANA 3 THE LENGTH OF LONG PKT(BITS). 102/02HJJE,XL INPUT QUEUR FJX 3/7 ... 102/02HJJE,P2,F3,P4,P2,P3 50 SELECT THE TKURK. HAPKI,PL,P2,F3,P4,P2,P3,P3 50 SELECT THE TKURK. *3,XE, FW POHT., DEPENDEING OR DESTN, XFER TO GORRECT LINK. ALSLEN H GESTIMMION # (1 - 8) TO PARA 1. SELZE F. JUESSON FOR SEKVIDE.
DESART CHFUL GULUE.
XFEK GEPENDINS ON PRIORITY.
ADD 5 MYEC FOR LOW PRIORITY.
JUMP TO CONTINUE.
ADD 3 MAED FOR HIGH PALORITY PROCESSING.
ADD 3 MAED FOR HIGH PALORITY PROCESSING. STD E LENGTH DF ANDREWS LANKI, LINKI. STDRE LEWGIH DF DETWICK TWANI, LINKZ. STDRE L. 4STH DF DEINLOK TRUKZ, LINKZ. STDRE LEASTH DF GENTILE TWANI, LINKS. ENTER PIDESSOR'S IMPUT OUEUE. 4 2 5 4 . 4 . . 4 . JUNE TO GONTANIE. SWITCH CONTROL MODDLE (SCM) POP11/70 LOGICAL TRANS15310M LINKS PHYS CAL TRANS45310M LINES (TRUNKS) ENIER THE HANDOCK NODE HERE · 教中的 · 在心脏,在一个一次的第三人称单数的 · 中,在人工也是是有心理情景的意思 NUDE HANCOCK PROCESSIVE DENIES 36,00HN021,XL 37,00HN022,XL 30,01HNQ31,4. 35,900 HNQ11,9XL . U1, HIGHS . U.Z., LUNG; 1, FNEDESTS FN, PAIOU \$ CUN 5 CUNL3 CON51 HNOUE HNOUE HIPS HMPSK . . . 2,2 2,1 3,1 * NETWORK PROKETS 12442F53 ADVAVCE RLEASE SAVEVALUE SAVEVALUE SAVEVALUE SAVEVALUE GENERATE TRANSFOR ASSEST SAVIVALUE ASSISI. 12A4SEER 435154 T 2448F22 1 44 45 FER A 3VA 40E TRANS F. R P 2 1 O 2 1 T Y LANGER HIGHS PALOWITY SSIGE LUMBY ASSECT MOI TON CONUS ASSESH U = F 12 T HANCK DIEUE HIPK CO:45.3 CONST HALLCO LUGRES 37.4H

每只要在人物中,这一点了一一样中原不会的情景的一点,也

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FRA ISFEL 1F A STATUS PACKET. TABULATE THIS PACKET'S TOFAL DELAY. BASED ON PALKET LENGTH, TRAISFER.	MASED ON PACKET PRIORITY, THA ISPER. BISID OF PACKET PRIORITY, TRANSFER IVER AT SELENDET DACKET DIE V.	DELOCATION TANKS DESCRIPTIONS DESCRIPTIONS SAUGE NETWORK. 1430LATE FRAFIUMS PACKET DELAY.	DELLVEN PROKET LOUALLY AND LEAVE NETWORK. I KAMLATE NON-PAT SHOKE PACKET DELLVEP PROKET LOCALLY AND LEAVE METWORK.	1 ABULAT FON-FAI LONS PACKET DELAY. DELLVER PACKET LOCALLY AND LEAVE METWORK. UNDELLVERGELE PACKET TERMINATION.
P3,C, HAME1 K1 IME FN, IMFUN	FN9TMPSS FN9TMPLS	KTHIL	RILUS	RTLOL
TENMO 7557 LE 1490, ALS 164HSFER	THEAD TANGEDA	HAMAL LAGUATE	HALOS JANULATE	HAL OE 1490, ATS 15441 NATE UNDES TSKINATE
TENHO	18HAS TMIAN	HAHAL	HAL 03	HAL OF UNDES

LINK I IS HATE UP OF I TRUNK TO ANUREMS.

H.4K11	HAK11 0JEUF	HNOIT	ERTER DUTPUT OUEUE FUR TRUNK 1,1.
	SE 4.75	HHTX1	SEIZE TRUCK 1,1 FOR SERVICE.
	1:8430	HN011	DEPART CUIPUL QUEUE.
	1 <445 FE2	FN, 44611	XFEE ULPENDING OF PACKET LENGTH.
HWC 11	HOVANOR	101	ACD 16 1080 FOR STATUS PACKET PROS
	* 25 ST: 47 L	* CON *	JUMP TO CONTLAID.
44041	ADVAVOR	55	ACU 27 MATO FOR PACKED XMISSION.
	と じょよいがとし	, CUN54	JUNE TO CONTANDE.
HAL 11	10747F	27	ALD 110 HSEC FOR PACKET XHISSION.
Cover	CONF. RELEASE	H.17K1	RELEASE FRUIK 1,1.
HAIL 11	HANAL I CANTERY	S YCNA .	JUMF 10 ADDE ANDREWS.

LINK 2 13 MATE UP OF 2 TRUNKS 10 F1.0ETRICK.

HNK 21	HNK21 OUEUL	H4021	ENTER DUTPUT QUEUE FOR TRUNK 2,2.
	S 21 75	HNT K2	SELTE 1 JUNK 2,2 FOR SERVICE.
	DEPART	HN921	DEPART JUTPUT QUEUE.
	1 42-15 FE &	F 14, M4 621	XFEW DEPENDING OF PACKET LENGIN.
HAC 21	HONKACK	10	AND 16 ISEC FOR STATUS PACKET PROC
	TRAISFER	CONSE	JUMP TO GENIINUE.
HAS 21	ADVANCE	2.7	AUD 27 HUFE FOR PACKET XMINSTON.
	4 72 - 12 FEB.	\$ COND \$	JUNE TO CONTINUE.
44L 21	PAL ZI ANVAVE	100	ACD 173 45EL FOR PACKET XMISSION.
53.15.	1.31213.7	HHJ 42	KELLASE FRUNK 2.2.
HA1, 21	HAN 21 1 84 15 FT 8	, F 10£3	JUAF 10 F1.0E1 41CK.

	600	THE ANTICE ANTICH CAN TRIBLE S. T.
36 15 S	HITKS	SELVENTURE 2012 FUR SERVICE.
DEPART	HN922	DEPART OUTPUT QUEUE.
7.348F.87	FN, H4 G22	XFCF DEPENDING ON PACKET LENGTH.
HACZZ ADVANCE		ADD 16 HISED FOR STATUS PACKET PROC.
1 (415)	4 0000	JUPP 10 CONTINUE.
HASSS ASVALLS	27	AND 27 HALC FOR PACKET XMESSION.
* 1 * 4 4 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	o Cursto	JUMP TO CONTINUE.
HALES ADVAVOL	100	ADD AIR METH FOR PACKET X41.5010M.
	H.41K3	AFECASE TYDIK 293.
HANZZ T SAUSFER	, FTDE 2	JUME TO 100E FI.DUTRIOK.
* LINK 3 1S MA	MANE UP OF 1 TRUNK	NK TO GENTILE.
HNK31 0JETE	HH031	PALEA DUTFUT PULUE FOR TAUNK 3.1.
	TENTE	.4 FOR SERVICE.
USP 15.	HNAST	ULFELT BUILDI SULUE.
1 < 4.15 F C 2	F11, 44631	XFE: DEFEROING ON PACKET LENGTH.
HAC 31 FOUNCE	15	ALD 16 HOLL FOR STATUS PACKET PROC.
しょうけいせい	, Covis 7	JUMP 10 COMITNUE.
HASSL ADVANCE	21	ADD 27 MSEC FOR PACKET XMISSION.
10848 668	COND	いいかけいのい・
MAL ST. AUVAVOS	luc	
	HNIKE	
HAW 31 T CA 45 FER	, GENTS	JUMP TO HOBE SENTILE.
• • •		
* * * * * * * * * * * * * * * * * * * *	经分分分的 化苯基苯酚 医克勒氏原染液 化多拉斯基 化二二苯二二酚苯 医电影电影	医唇体腺 医克克勒氏虫虫虫病 人名英格兰人姓氏克勒氏
* NOJE 7' JET L * SWIT	2 SMITCH CONTROL MODULES (SOM)	CENTER (SOM) PUP11/24'S
1907 8	LOGICAL TRANSMESSION LIVES	•
	CAL TRANSMICS	TON LINES (I YOUKS)
****	****	南南一角中华东西山南西南西南西 南西斯山西人名中南西西
ROOLE GENEVALE	77,FNUEXPON:	77, FNUEXPON, 1999 F GEN. PACKEIS & 20% DAI MEAN OF 77 MSEC
	• Ull, HIUHS	1% OF PAUKETS ARE HIGH PRIORITY.
ASSISA	, .	DENOTE HOLLELLE AS SOUNDE NOTES IDAG.
	2.1	STATE THE PERCHANANCE OF TAX
TAMASER	, CON51	JUMP TO CONTINUE.
PIGHS PRIORIFY	2	MARK THIS PACKET WITH HIGH PRIDKITY.

```
SIDE AN PARA 2 THE PLAURITY OF 2.
62% OF PACKLTS ARE LUNG.
SIDE IN PARA 3 THE LENGTH OF SHORT PRIGBITS).
                                               JUMF TO CONTINUE.
SLANK IN PANA 3 THE LEMUTH OF LUNG PKT(RITS).
ASSIGN A CENTANATION # (1 - 8) TO PARA 1.
SEYN HALF OF PKIS TO PROCESSOMS #1 ( #2 MESP.
                                                                                                                                                                                                                                                                         KEE DEFENDING ON PRICKLY.

ADD 5 MIED FOK LOW PRICKLY.

ADD 3 MIED FOK LOW PRICKLY PROTESSING.

ADD 3 MIED FOK LOW PRICKLY PROTESSING.

ADD 3 MIED FOK LIGHT PROCESSING.

RELEASE THE PRUCESSUM.

STORE LIMSTH OF GENTLE FANKS, LINKS.

STORE LIMSTH OF TINKER TRAKS.

STORE LIMSTH OF TINKER TRAKS.

LINKS.

LINKS.

LINKS.

LINKS.

LINKS.

LINKS.

LINKS.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ENTER SOM 2'S INPUT QUEUE.
SEIZE THE PROCESSUR FOR SCRVICE.,
DEPART OUTPUT QUEUE.
XFEW DEFENDING ON PRIJALIY.
AND TO GOTHING.
JUNP TO CONTAINE.
ALD 3 MAC FOR HIGH PALONITY PROCESSING.
REFASE FHE PROCESSOR.
STORE LEAGTH OF GUHTLE TANKI, LINKI.
STORE LEAGTH OF GEHILE TRNK?, LINKI.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PA, PI, P GO SELECT THE TAUNK.

1-1NSFE THE TOUK 10 # TO PANAMETER 5.

DEPENDING ON DESIN, XFEM TO COMMENT LINK.
                                                                                                                                                                                                                              ENTER SCH 1'S IMPUT QUEUE.
SEIZE 1HS PRODESSON FOR SERVICE.
DEPART INFUT QUEUE.
                                                                                                                                 * METWORK PROKETS ENTER THE MOCLELLAN NODE AT PUTNISS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                MCPKR1, P1, P2, F3, P., p1, p
                                                                                                . > , 400L11, 40GL2
                                                                                                                                                                                                                                                                                                                                                                                                                                            172, 02 MCOJI, KL
173, 03 MCOJE, K.
                                                                                                                                                                                                                                                                                                                                                                               +UPBANCOLZ, KL
                                                                                                                                                                                                                                                                                                                                                                                                41,00HC021,XL
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+U,02HCQ12,XL
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                                                                                                                                               MODLE - FOR SON #1.
HODLE - FOR SON #2.
                  .62, LONGS
                                                                                1, FREDESTS
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+1,05MC0261,XL STDAE LEMSTH DF NORTON TRAKE, LINK2-42,05MC071,XL STDRE LEMSTH DF TENKER HEMXE, LINK3-43,02MC071,XL STDRE LEMSTH DF TENKER TRAKE, LINK3. 172,05MC071,XL INPUT OUTUE FOR SCH 1. 173,02MC071,XL INPUT OUTUE FOR SCH 1. 173,02MC71,XL INPUT OUTUE FOR SCH 1. 173,02MC71,XL INPUT OUTUE FOR SCH 1. MCPKKI,PL,P2,P3,P3,P1,P1,P1 GU SCLEOT THE TRUNK. MCPKKI,P1,P2,P3,P3,P1,P1,P1 GU SCLEOT THE TRUNK. D,XF5. TEANSFE. THE IGUNK 10 # TO PANAMETER 5. FM,40010. DELIVER PACKET LOCALLY AND LEAVE MEIMORK.
THEULHT FELLONS PACKLT DELAY.
DELIVER PACKET LOCALLY AND LEAVE NETWORK.
TABULIT NOW-FALL SHOW! PACKET OFLAY.
DELIVER PACKET LUCALLY AND LEAVE WEIMORK. DELIVER PROKET LOCALLY AND LEAVE NETWORK. ENTER CUTFUT QUEUE FUR THINK 3,2.

SELTE THUNK 3,2 FOR SENVICE.

DEPART GUIPUT QUEUE.

XFEP DEPENDING OF PROKET LENGTH.

AFO 16 MYEU FOR STATUS PACKET PROC.

JUMP TO CONTINUE.

ASO 27 MSEC FOR PACKET XMISSION. TEALSEE IF A STATUS PACKET.
143ULATE THES PACKET'S TOTAL DELAY.
845ED ON PACKET LENGTH, TRANSFER.
945ED ON PACKET PRIORITY, TRANSFER.
945ED ON FACKET PRIORITY, TRANSFER.
148ULATE FRI-SHOKET PROCKET ULLY. TABULATE NOM-PAY LONG PACKER DELAY. JUMP TO CONTINUE. AGD 100 ASEC FOR PACKET XMISSION. Releave Frunk 3.2. UNDELLURABLE PACKET (EPMINATION. LIRK 1 IS MAPE UP OF 2 TRINKS TO GENTILE. TAUNK TIS CONNECTED TO SCHILL IN US AS SCHILL STANDAR OF TIS CONNECTED TO SCHILL STANDAR OF TIS CONNECTED TO SCHILL STANDAR OF TIS CONNECTED TO SCHILL SCHILL STANDARD OF TIS CONNECTED TO SCHILL SCHIL JUIPUT PAJCED SING FOR SCH 1. P 5,2, MC'151 FN, TAPUS FN, TAPSO FN, TAPLO FN, MCF31 CONDI くいだいり RTINE MCOST ATELS KTHIL ATLUS MC TK2 401K2 .o SAVEVALUE SAVEVALUE SAVEVALUE T CA 15 FG 2 HLG31 ADVINGE GONDO A EL 55 SF 124411475 EXMINATE SAVEVALUE SAVEVALUE MCHIS TABILALE TERMINITE TIN 11 14 TE BLAND TOTAL GEOM 1 CA 25 FO C **プロリンドサンし** 31436641 MOHIL TABULALE PCL 05 T16/1_HF HOLOL TARYLAFE T AN 15FER MOUSE A DVINCE 132 11 cE3 TEAMS 1555 LS BONTACA 18HSM \$41.7E 0501.1 NOISER HCL 31 O'JE JE 11.73 7 4403 1480L

NE 031	T LAWSFT.	TNKKI	BUAP TO NODE TINKER.
MCL 12	0.150 SALTE ULPANT TRAMMERS	MC012 MC fks MC012 Fu.MCF12	ENTER OUTPUT PUBLE FOR TRUNK 1,5. SEIZE THUNK 1,2 FOX SERVICE. DEPART CHIFUT QUBUE. XFER DEPARTMENTS ON PACKET LENGTH.
NG0 13	1)VANO	!	AUD 16 4510 FEL. STATUS PACKET PROG.
RSHLZ	60VA165 TRAUSFER		ACO 27 13EC FON PACKET XHISSION. JUMP 10 CONTINUE.
File 12 Cuers	00/4/CV 00/4/CV	10J HCTKS	AUD BLU MAED FOR PACKET XAISSION. AF FAME FAUNK 1.5.
HEU 12	1 to 11 F. 2		JUMP 10 NOCE GENTILE.
	OUTPUT PROCE	FESTAG FOR 334 2.	
MCL 21	30.500	HC021	ENTER OUTFUL SUEUE FOR TRUNK 2,1.
	54175		SELZE TOUNK 2,1 FOR SERVICE.
	DEPART A SERVICE O	40021 Fr.47624	DEPART SOLPOI SOLDE. Kriss From Soles Soles Dancker Frenche.
FC0.21	73.57 KV 1	4	ACD 16 ASEC FOR STATUS PACKET PAUC.
	1 CA. 40 F E.	7457	JUMP TO CONTINUE.
HSH21	#34704	:	ALD 27 HILL FOR PACKET XMISSION.
3	グロエルフィント	7 cN0 5	JUST TO COUTLY OF BACKET VATISTAGE
	けいがいる。	HC7K1	.
	T 44.45 FF 2	, 110x1	JUME TO NOOR NORTUN.
HGL 32 (OJEU-	10932	Urbut sugue F
	35178		SELTE TOWK 3,3 FOR SCRVICE.
	トンベルリニ ペール・ファイン	40032 FN_M0432	SULPU: DUEUS. PENDING UN PACKET FENSTH
#CC32	ADVAVOR		AND 16 4380 FOR STATUS PACKET PROC.
	1 (A. V.) FITA	S CUITA	TOTAL TO CONTINUE TO A CONTINU
10.00	1 22 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2		ADD 67 13:0 FOR PACKEL AMINORUM. JUMP TO CONTINUE.
MLG 32	ADVANCE		APO 1.0 date for PACKET X413SION.
CONTRACT	10.50		KLLLASE TRUIK 3,3.
M20.32	4 25 18 F.C.	, I kk 2	JUMP TO WOOL TINKER.
P.CL 11	0.7515		ENTER OUTFUT GUEUE FUR THUNK 1,4.
•	SETA		SEIZE TRUNK 1, FOR SERVICE.
•			OBPART JUIPHI JUEUS.
M3011	1 (4 15 FEX 10 10 10 EE	16	ATEN DEPOYMENT ON PACKET LENGTH. ALD 16 MSEC FUR STAINS PACKET PROC.

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JUHF 16 SCNITHUL.
SIDNE AH PANA, 3 THE LENGIH OF LONG PKTIBLIS).
ASSIGN A SESTIMATION # (1 - 8) TO PARAMETK 1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 HARK THIS FACKLI WITH HISH PRIORITY.
$10ak In Fana 2 THE PAIOKITY OF 2.
b2% OF PACKIS ARE LONG.
$10ak IN FANA 3 THE LENGTH OF SHOKE PKT(BITS).
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ENTER PROCESSOR'S INPUT QUEUE.
SEIZE THE PROCESSOR FOR SERVICE.,
UFPART THPUT QUEUE.
XEEK BERENDING ON PRIDRITY.
AUD V MAIC FUE LOW PRIDRITY PROCESSING.
JUMF TO CONTINUE.
AUD 3 MAIC FOR HIGH PALUKITY PROCESSING.
AUD 3 MAIC FOR HIGH PALUKITY PROCESSING.
AUD 3 MAIC FOR HIGH PALUKITY PROCESSING.
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                                                                                                             400 100 MSFC FOR PACKET XMISSION.
AFLEASE TRINK 1.4.
JUMP TO ACOL GENTILE.
JUMP TO CONTINUE.
AGD 27 HISC FUR PACKET XMISSION.
                                                                                                                                                                                                                                                                                                                                                                       中,在最后的在自己的中心中,这个有一点,在我们也会的是这种情况是是有人的是是一种,我们也没有的人的是什么的。
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     安全的安全的现在分词 医水子 "我是你,我们也不会的现在分词,这些是是有一个不是不是,我只要不是一个,我们也会会会会会会,我们们
                                                                            JUMP TO CONTINUE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                JUMP TO CONTINUE.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        MUDE MORTON PROCESSING SENTER
1 SMITCH CONTROL MODDLE (SCM) PUPIL/7U
3 LOGITAL THANSMISSION LINKS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               PHYSICAL INANSAISSION LINES (TRUNKS)
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MCTK4
• GENT2
   , CUN59
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CU.173
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1841SFF LE STAIUS PACKLT.

TABULAT: THIS OLGKET'S TUTALSF.R.

945-D UN FACKET' ENGINE, TRANSF.R.

945-D UN FACKET PRIVALITY, ITANSFER.

945-D UN FACKET PRIVALITY, ITANSFER.

143-ULAT FAL-SHORT PROKET DELAY.

DELIVER PACKET LOCALLY AND LEAV.

169-LVFR PACKET LOCALLY AND LEAVE NETHORY.

169-LVFR PACKET LOCALLY AND LEAVE NETHORY.

160-LVFR PACKET LOCALLY AND LEAVE NETHORY.

160-LVFR PACKET LOCALLY AND LEAVE NETHORY. 40,0340021,XL SIDAE LENGTH OF GEWILLE TENKI, LINK2, 47,00,0031,XL SIDAE LENGTH OF ACCIELAN INNKI, LINK3, 162,02400715,XL INDUT QUEUE FOR SCH 1.

NOPKRI,P1,P2,P3,P1,F2,P7 GO SELECT THE TAURK, 1 NATSFE: THE TAURK 10 # TO PAAAMELEA I.
FW:COUT? DEPENDING CH DESIN, XFER TO CORPECT LINK. XFER DEPCYDINGON PACKET LENGTH.
AUG 16 MSEC FOR STAINS PACKET PAGG.
JUMP 10 OCHTIVUE. XFER DEFINDING ON PACKET LENGTH. ALO 16 YGEO FOR STATUS PACKET PROC. ENERA OUTPUT OUEUE FOX TRONK 1,1. SELZE TRONK 1,1 FOR SCRVIOE. DESART HOTPUT DUEUE. JUMP TO CONTINUE. AED 116 45EC FUR PACKET XMIUSION. RELEASE THE TRUMK 1,1. ENTER OJPUT JUEUE FOR TRUNK 1,2. SELZE TOUNK 1,2 FUR SERVICE. DEFAST CUIPUT JUEUE. AUD 27 HSEC FUR PACKEL XMISSION. ACO 27 ISEC FOR PACKED XMISSION. JUAR TO MODE ALBANY. JUMP TO CONTINUE. 2 TRUNKS 10 ALBANY. P3,2, NOMEL FN, 1MFS? FN, TMPL? FIL, NUG 12 FN, IMFU7 FN,NOG11 LINK 1 IS MAPE UP OF , CON/4 , ALBN1 4 C 01474 CUNY 5 NO 211 NO 241 NO 241 KU012 NOTK2 NU012 3KT [2 XIHIX ATHIL RILOS 1401K1 FILOL JULPUT PROCESSING SAVEVALUE SAVEVALUE HOLOL TABULATE TEKNIMATE UNDEZ TEKNIATE 14 19. 47. 3 24.45 F F E 144.03 T 44.45 F E E 194.01 1 44.45 F E E NOHIS TAP 1.0 F E MOLOS TARULALE TERATUATE SAVEVALUE TER MENATE T CAME FER A 20 10 CE 21167747 TOWARD AST TAMBERS HOULL ANAMOS Tim Defections to the Notion House NO. 11 1-44-15-FER T 24 NS FT 2 TENMY 1457 LT NOL11 AJVANCE DEP 1:1 COAP ASLERYS 1.0512 A 1VAVOT METERA 5-117: DEPA:T CdJIH ROK11 03595 Sal7: DJEUF NOK 12 NO.12

TAMBESA NOL12 ADVANCE COMPS NELESSE FOL12 PARREFE?	, CON75 101 NOTK2 , AL742	JUMP TO CONTINUE. ACC 11, MSEC FUR. PACKET XMISSION. VELEASE 14UNK 1,2. JUMP 10 MGCE ALGANY.
TING 2 IS HD	MARE UP OF 1 TRUNK	TO GENTILE.
**************************************	MOD21 MOT43 MOD21 FN,NU621 16 CON76 CON76 CON76 100 MOT43	ENTER DUTFUT OUCUE FOR TRUNK 2,3. SELTE TRUNK 2,3 FOR SERVICE. DEPART OUTFUT OUEUE. XELE LEBENDLIS OUEUE. ADD 16 1360 FOR STATUS PACKET PROCUMP TO CONTINUE. ADD 27 4SLC FOR PACKET XMISSION. JUMP TO CONTINUE. ADD 16 4SEC FOR PACKET XMISSION. JUMP TO 40DL SENTILE.
4 LINK 3 15 M	MATE UP OF 1 TAUNK	TO MCCL-LLAN.
**************************************	NOG31 NUTC4 NUG31 NUG31 FN,NUG31 16 , CUN77 27 20 10 HUTK4 MUGL2	ENTER OUTFUL DULUE FUX TRUNK 3,:. SELZE T UNK 3,4 FOX SENVIGE. DEPART UNIPUT DULUE. AD 1v 45EC FOR STATUS PACKET PROC JUMP TO CONTINU. ASD 27 ASEC FOX PACKET XMISSION. JUMP TO CONTINU. ASD 27 ASEC FOX PACKET XMISSION. ADD 10C MSEC FOX PACKET XMISSION.
* NOJE TANKER * 3 SWITOP * 5 LOSLO? * 4 3 PHYSIF	LUKER PROCESSING CENTER SMITCH CONTROL MODULES (SCM) LUGALOLL FRANSMISSION LINKS PHYSICAL TRANSMISSION LINES	EK 5 (3CM) PDP11//0*S * LINES (1RUNKS) * *

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JUHE TO CONTINUE.

STORE THE PACKET WITH HISH PRIORITY.
STORE IN FACA 2 THE PAJONITY OF 2.

OUR OF PACKETS ARE LONG.
STORE IN FACA 3 THE LENGTH OF SHORT PAT(BITS).
                                                                                                                                                                                    S105E IN PARA 3 FM2 LENGTH OF LONG FWT(BITS).
ASSIGN A DESILHATION # (1 - 8) TO PARA 1.
SEND ON! THIRD OF PACKETS TO PROJESSOR #7.
SEYD FHIRD OF PKIS TO PROJESSORS #1 #2 ALSO.
32,FNDEXPON,,,,F SEN, PAJKETS D 20% SAT. - MEAN OF 32 ASEC.
.01, HIGH3 1% OF PAGKETS AND MIGH PRIOKITY.
.,6 DENOTE TINKER AS SOUNDE NOOF, ID=8.
MARK THIS PAGKET WITH LOW PRIOFITY.
2,1 SIDEE IN PAGK 2 THE PRIOKITY OF 1.
                                                                                                                                                                                                                                                                                                                                                                                        ENTER SCH 1'S INPUT QUEUE.

SEIZE PAODESSOM FOR SEWVIDE.

DEPART INFUT OUEUE.

ADD B MYED FOR LOW PALOHITY PROCESSING.

JUMP TO CONTINUE.

ADD 3 MYED FOR HIGH PRIORITY PROCESSING.

ADD 3 MYED FOR HIGH PRIORITY PROCESSING.

SIDGE L'ASTH OF ALBANY IRWER, LINKE.

SIDGE L'ASTH OF ANDREWS TRIKE.

SIDGE L'ASTH OF ANDREWS TRIKE.

SIDGE L'ASTH OF GENILE INHES, LINKE.

SIDGE L'ASTH OF MOCLELLAN INHES, LINKE.

LINFUT OUTUE FOR SCH 2.

LINFUT OUTUE FOR SCH 2.

LINFUT GUIUE FOR SCH 2.

LINFUT GUIUE FOR SCH 2.

LINFUT GUIUE FOR SCH 3.

P3,P ,PE,F GO SELECT THE TRUNK.
                                                                                                                                                                        JUME TO CONTINUE.
                                                                                                                                                                                                                                                                          * NETWORK PROKETS ENTER THE TIAKER NOVE AT FOTHTS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       (IPKKI, PI, F2, P3, P , PF , F
                                                                                                                                                                                                                         • 333, • TNKR3
• 5, 1 NKK1 • FNKR2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 43,03TKQ21,XL
> 0,04TKQ22,XL
> 1,03TKQ31,XL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     53,02TK041,XL
54,02TK0-2,XL
52,08TK031,XL
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      15,011K032,XL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    40,0sfK011,XL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      22,021K032,XL
                                                                                                                                                                                                                                                                                          TAKE - FOR SOM #1.
TAKE - FOR SOM #2.
TAKET - FOR SOM #3.
                                                                                                                                         . 52, 1 LUNG3
                                                                                                                                                                                                           1,FNSDEST3
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ACC 3 MSEC FOR MIGH PRIORITY PROSESSING.
ACC 4 MSEC FOR MIGH PRIORITY PROSESSING.
STORE LENGTH OF ANDREWS TRAKE, LINKS.
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STORE LENGTH OF DETRICK TRAKE, LINKS.
STORE LENGTH OF GENTILE TRAKE, LINKS.
STORE LENGTH OF GENTILE TRAKE, LINKS.
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J. XF.
J. XF.
FN, XOUT9
DEPENDING ON DESTW, XFLR TO CORRECT LINK.
DEPENDING ON DESTN, XFER TO CORRECT LINK.
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50,0,TK022,XL
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TABLL ATE THIS PACKET'S TOTAL DELAY.

RASED O'T PACKET LENGTH, TWANSFER.

SASED ON FACKET PRIOWITY, TWANSFER.

BASED ON FACKET PRIOWITY, TKANSFER.

TREULATE PACKET PACKET DELAY.

JELIVER PACKET LOCALLY AND LEAVE NETHORK.
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DELIVER PACKET LUCALLY AND LEAVE NETWORK.

TABULATE NON-PAL SHOWT PACKET DELAY.

DELIVER PACKET LOUALLY AND LEAVE NETWORK.

TABULAT'S NON-PAL LONG PACKEL DELAY.

DELIVER PACKET LOCALLY AND LEAVE NETWORK.

UND-LIVERABLE PACKET TERMINATION.
                                                                                                                                                       DEPENDING ON DELIN, KPER TO CONNECT LINK.
59,08TKO51,XL SIDGE LENSTH DE MCCLELLAN TENKI, LINKS.
195,01TAJ1,XL INPUT QUEUE FOR SCH 1.
195,02TIOJ2,XL INPUT QUEUE FOR SCH 1.
195,02TIOJ2,XL INPUT QUEUE FOR SCH 2.
195,137TIOJ3,YL INPUT QUEUE FOR SCH 3.
TIPKRT,P1,P2,P3,P4,P5,F2 60 SELECT THE TRUKK.
5,XF3
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OFPAKT OUPUT DULUZ.
XFEN HEPENDING ON PACKET LENGTH.
ACO 16 MSEC FUR STATUS FACKET PADG.
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THURK 1 IS COUNCOTED 10 SCH 3.

LINK 2 IS MACE UP OF 2 FRJUKS TO ANDREWS.

TRUCK 2 IS CONNICOTED 10 SCH 3.

LINK 3 A MACE UP OF 2 FRJUKS 10 FT. DETAICK.

TRUCK 4 IS COUNCOTED 10 SCH 2.

TRUCK 5 IS COUNCOTED 10 SCH 2.

LINK 4 TS MATE UP OF 2 F3JUKS 10 GENTELE.
                                                                                                                                                                                                                                                                                                                                                                                                       TAUM 6 13 COMMANTED 10 504 3.

TAUM 7 18 COMMANTED 10 SCH 1.

LINK 5 15 HAFE UP OF 2 TAUMS TO MCCLELLAN.

THUM 9 18 COMMANTED 10 SCH 2.

TRUM 9 18 COMMANTED 10 SCH 1.
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FN,TMFUO
FN,TMPLO
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JUMP TO CENTINUE. ADD 27 MSEC FOW PACKET XMISSION. JURP TO CONTINUE. ADD 10C 15EC FOW PACKET XMISSION. KELFASE TOUR 3.55. JUMP TO NODE FI.DETRICK.	ENTER OUTPUT DUEUF FOR TRUNK +,7. SELZE THUNK 4,7 FOR SENVICE. DEPART OUTPUT DUEUE. XTE. DEFENDING ON PACKET LENGTH. ACO If GYEU FOR STATUS PACKET PROC. JUMP TO CONTINUE. ACO 27 MALC FOR PACKET XMISCION. JUMP TO CONTINUE. ACO 1 LU MSEC FOR PACKET X 11.5 SIO.4. ALLEASE TRUNK +,7. JUMF TO NODE SENTILE.	ENTER OUTPUT OULUE FOR TRUNK 2,3. SELTE TOUN N.9 FOR SERVICE. DEPART JUJIPUT OUEUE. XFE. ULPENDING ON PACKET LENGTH. ACJ 16 M'SEC FOR STAIUS PACKET PROC. JUMP TO CONTINUL. ACJ 14 M'SEC FOR PACKET XHISSION. JUMP TO CONTINUL. ACJ 14 M'SEC FOR PACKET XHISSION. JUMP TO GONTANUL.	ENTY OUTPUT CULUE FOR IRUNK 2,3. SELTE TRUNK 2,3 FOR SERVICE. DEPERT CUTPUT TUCUE. XFER DEPENDING ON PACKET LENGTH. ADJ 16 456 FOR STATUS PACKET PROC. JUHP TO CONTINUE. ADJ 27 VSEC FOR PACKET XMISSION. ADGS 100 GONTINUE. ADGS 100 GONTINUE. ADGS 100 GONTINUE. AUGH TO GONTINUE.
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110 St 40 11	1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2		ACO 16 MATC FOR MIMION PACKET PACE.
1SH31 AJ	LOVA CA		ADD 27 USEC FUR PACKET XMISSION.
11.631 1)	734574 737747	S C C S C C C C C C C C C C C C C C C C	ADD 1/0 GENITHDE. ADD 1/0 ASEC FOR PACKET X413SION.
	Libor	.+.	RELEASE TRUNK 3
	A 1SFER	FTÜE2	JUMF TO MODE FT. DETAICK.
TKLSA OJ	ćUE	TKOA	ENTER OUTPUT DUEUE FOR TRUNK 1984
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15451 AJ	77.47		AND 27 JOSEC FOR PACKET MAISSION.
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d (00 +	PUT PROCES	SING FOR SOM 3.	
1KL11 0J	JE 17		ENTER OUTPUT QUEUE FOR TRUNK 1,1.
.αν :	17: 17:	1X1X1	SEIZE TIUMK 1,1 FOR SERVICE.
, ·	* 10 Li 10 m	•••	MORRAL COLLEGE GORGES
15 11611 69	イドログマン	1	AND 16 DATE FOR STATUS PACKET PAGE.
	ALISFER	8880	JUMP TO CONTINUE.
18411 A)	!! しァベス		ADD 27 MSEC FOR PACKET XMISSION.
	4 1 L 4	9 0003 8	JUNE TO COMPINATE.
	11 11 11 11 11 11 11 11 11 11 11 11 11		CONT. 100 CONT. C.
	1 34 MS FER	~	JUMP 10 NOOE ALBANY.
1KL 21 ∩J	. 21 03EUE	T K Q 2 1	ENTER DUTPUT QUEUE FOR TRUNK 2,2.
20	17:	18182	SEIZE THUNK 2,2 FOR SEMVICE.
30	PART	1 K021	הפשפה שונה וואיים שנים שנים של מיו שונים של מיום של מי
~	A.N.FER	FN, 11121 .	XFEN DEPENDANG ON PACKET LENGTH.
11621 AD	VAVOE	10	ADD 16 MSEC FOR STATUS PACKET PROC.
> 1	10 10 10 10 10 10 10 10 10 10 10 10 10 1	CONGC	JUNEAU TO CONTINUE.
15861 4.3	: 1	, ,	ADDITION THOUSE AMENDED

JUMP TO CUNTINUE. ADD 110 MSEU FOR PACKET XMISSION. RELEASE TRUMK 2,2. JUMP TO MODE ANDREWS.	FNTEK GUTPUT GULUE FOR TRUNK 4,5. SEIZET UNK 4,3 FOR SLRVIDE. DEPART GUTPUT RUGUE. XFEN DEPENDING ON PACKET LENGIM. AGO IL USEC FOR STATUS PACKET PROC. AUTP TO CONTINUE. ADO IL WSEC FOR PACKET XMISSION. ADO IL WSEC FOR PACKET XMISSION. ADO IL WSEC FOR PACKET XMISSION. ACCEMSE TRUNK ++0.	PERIODIC ENFRY INTO MESGEN MESSEN IS ENFRES EVERY 183 MSECS TO CHECK FOR "BAD NEWS". THIS INCLUDES CHECKINS THREE (3) COMDITIONS: (1) HAVE ANY LEAKS GONE DOWN? (2) SINCE FHE LAST JIME MESSEN WAS ENTEREG, WAS THE NODE UNSAIDNATED. LAND. IS THE NODE CONRENTLY SATURATED? (3) ARE ANY OF THE LINKS COMSESTED?	IF THE ANSWER TO (1) OK (3) IS YES, ONE OF TWO TYPES OF (1) IF THE CUSKENT DIATOS OF THE NODE IS UNSATURATED, A STATUS HESSESE IS GENERALD THAI SELECTIVELY FINDS THE LINKS THE APPROPRIATE VALUE IN THE STATUS TESSAGE. (2) IF THE CUSKENT STATUS OF THE HODE IS ONE OF SATURATION, A STATUS HESSAGE IS GENERATED WHICH DECLARS ALL THE LINKS SOUGHED. IF THE ANSWER TO CONSITION (2) ABOVE IS YES, THE STATUS OF THE MODE IS SET TO SATURATION (2) ABOVE IS YES, THE STATUS OF THE MODE IS SET TO SATURATION AND A STATUS MESSAGE IS GENERATED DEFLACENG ALL THE LINKS CONGESIED. IN ANY OF THE TREE CASIS, 9 SORY OF THE STATUS MESSAGE IS SENT TO ALL THE NETWORK WOODS AND A COPY IS SENT TO THE UPDATE	F GENERATE PACKET EVERY 103 MSFC FOR HESGEN.
, CON3C 106 TKTK2 , ANDY2	TKG41 TKTK5 TKG41 FN,TII+1 CON-0 27 CON-0 140 TKK5	STRIUDIO EN ES EN INCLUDE LO HAVE ANY CONSTRUCTOR CONS	ST. TUS MESSAS ST. TUS MESSAS ST. TUS MESSAS A STA FINE A STA A ST	103992999F
TRANSFER ADVANCE KELFASE TRANSFER	00Jeus 02178 02PNT 14ANSERS ADVANOS AD	CJUE FJR PTRIUDIC FTIJK - MES GEN IN THIS INCL (1) HAVE A (2) SANGE UNSAIN	ស្នងគិនិងដី	GENEVALT
7621 00350 11321	1KL41 1+C41 1SH41 1L641 1+341	• • • • • • • • • •		
·	· ·	Section 2	(→ ③

€		PRIOFITY ASSIGN ASSIGN	2 . 2 . 2 . 3 . 3 . 3 . 3 . 3 . 3 . 3 .	GIVE IT PETORIY CLASSIICAFIUN. STORE IIS PKLOLITY IN PARIMETER 2. STORE STATUS PKT LENGTH (382)BITS IN PARA 3.
	• • •	O'G NESSEM	PLOCESSING AT ALBANY	>
	ALBME	SPLII	1930JAE	SEAU A COPY TO DESSEN SUB & AMBREMS. REF FLAG FLA BAIL MEMS PALISTS STAGE
	AL 3M1	QJE118	ALM1	QUIUL PLOKET TO INHIBIT SEMULIANEGUS PROC.
		SEL7:	Mc.P1	SELZE TERE TO RUN MESSEN.
_		- / T. L.O.	1000	SIDTE ALBORY ID # AS LOURDE NUDE.
ě		5 1V - VAL UE	125 pt , XL	SEI FLAG FUR TRANSMISSICH DECISION.
ب ا ا		HELDE	ALMSGN, P1, P2, 33	PASSENGE OF EXECUTE MESSENS
		NELEGYSE Jest L	MESPI XL125-1-ALANY	EVANUE FAULTHER AGN OF MENGERA. DIS ME SEVERALE A STATUS AESSARS?
		TENT NATE		
	ALBNY	iIles	1, ANDW1	YES, SEUT A COPY FOR ANDREWS PREPARATION.
			1,1	ASSAGN MOST - NOOF AS ALGAMY.
	ALMET	0,35.95	ALMOZ	DUEUE PKI TO LAHIBIT SIMURITANI O PAUC.
		V L L L L L L L L L L L L L L L L L L L	ALMON TO THE COLUMN TO THE COL	SELVE 17.12 FOR UPDATEDING IN MIN CONFOLE U
_		1	ALM32	ALMOS LEAVE 14E 705(15)
ě	-	AMELO:	ALINIO, P1, F2, F3	ALINIO, PL, F2, F3, P1, F2, F ALINITALIZE THE LO FOL W/ NEW INFO
 }		JASE P.	ALCUMD, P1, P2, 53	PASSING RECURPOIS D'ABLES HOP & LIST MERAYS.
			ALMSP	ENABLE HOPAILS ANTITAL DIAND COMPUTE DIFOR USE
	ALMED		ALMOS	QUEUF PKT TO INSTALL SIMULTANEOUS PAGG.
		SEI / E	ALROS	SEIZE TOTE TO NOW KINGER. LEGVE THE COULD.
		HEL 35	ALM 3L, P1, P2, F3	ALMINE, PAS, PZ, PZ, PZ, PZ, PZ, PZ, PZ, PZ, PZ, PZ
(S 12 10 8	ALMS1	AELEASE FUN USE OF ANDIHER PACKET.
т Э	3 5 6 L	128.41 MATE 00: 11	1.0ET04	APPLOAD THE PERMIT FECT THE SYNTEM.
		11011004	1,2	MAKE DESTINATION NODE ANDREWS.
		THA INFER	. 5 , AL BH1, 1LB.12	60 TRANSALT STAI TO ANDREAS.
	CEI R	SPLEI	1,6º HW1	SEAF A POFY FOR GENTILE'S PHEPARATION.
		ASS 1311	£ 6¶	MAKE DELINATION NOOL DETRICK.
_	N 3	1 45 15 15 4 69 17	. 5.9AL 5N1.91L3.42	GO TRANS 411 NIA 10 DELYLUK. Asian a conv. Hen Handlokan Preparation.
9			1011111	MAKE DESTINATION HODE GENTILE.
		T 23 17 F.2.2	. PALBNIPALBAS	60 TAANSAIT STAT TO GENIILE.
	HANCI	1.26.4	1, MOLE 1	SELO A COPY FUR ACCLERLAN'S PREPARATION.
		704577	190 6.81 DN4 11 349	BEACH DESCRIPTION NOTE TOOM DESCRIPT.
-	ינינו	11769	1,NORT1	SEND A COPY FOR MUNTON'S PREPARATION.

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MAKE DESTINATION NODE MUCLELLAN.
60 TRANSHIT STAT TO MOCLELLAN.
SENU A COPY FOL TINKEL'S PREPARATION.
MAKE PENTINATION NODE NOKFON.
60 TRANSHIT STAT TO MUSION.
MAKE DESTINATION NODE TANKER.
                                                                                             NOTE: COMMENTS ARE NOT ADDED TO REDUNDANT CODE BELOM: THE TENSTOCITIONS OF ESSENTIALLY THE SAME THING AT EACH NODE:
                                                                                                                                                                                                                                                                                                                                                           AMUNOT, P1, P2, P3, P4, P5, P6, ANIMIO, P1, F2, P3, P4, P5, P5, ANGO10, P1, P2, P3, P4, P5, P0,
                                                                                                                                                                                                                                                                                                                                                                                                                                          ANRIBL, P1, P2, P3, P4, P5, P6
                                                                                                                                                                                                                                                   AHIISGN, PI, PZ, P3, P4, P5, P0.
MESP2
                                                                                                                                           MESSEN PROCESSING AT ANDREWS
            . SIALBNI, 1LBV2
                                                                       . DIALBNI, ILANZ
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1,654N2
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DEUPDT,P1,P2,P3,P4,P5,P6
DEINIO,P1,P2,P3,P4,P5,P6
DECCYO,P1,P2,P3,P4,F5,P6
ULMSP
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DEMS1
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DEMSGN,P1,P2,P3,P4,P5,P6
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GENS1
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HANSON,PI,P2,P3,P4,F5,PE
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MCUPO1,P1,F2,P3,P1,P5,P6
MCIN10,P1,P2,P3,P4,P5,P6
MCCU40,P1,P2,P3,P4,P5,P6
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MUMISL, P1, P2, P3, P5, P5
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NOMSGN,P1,P2,P3,P1,P5,P1.
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NUUWD1,
NOLW10, P1, P2, P3, P4, P5, P5
NUCUWD, P1, F2, P3, P4, P5, P5
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NUMSP
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NOMTAL, P1, F2, P3, P4, P5, PC
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111N10,P1,P2,P3,P4,P5,PC
11CO40,P1,P2,P3,P1,P5,P5
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TIMO3
TIRIJL,P1,F2,P3,P1,F2,P5
TIMS1
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. b, TNKR1, TNKR2
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GIVE AT PRIDGATY CLASSIFICATION.
SET FRANCHIEN 2 WITH THE PRIOPITY.
SET PARAMETER 3 WITH THE SPECIAL LENGTH.
SEND LURY FUR ANDREWS PREPARATION.
SET FLAG FOR STICK PROCESSING.
GO THEO SAME PROCESSING AS FILSK.
MEDGEN IS ENTEKED EVERY NOT MEDGEN TO CHECK FOR "GOOD NEWS".

THIS INCLUDES CHECKINS THRUE (3) CONDITIONS!

(1) HAVE ANY LIAKS COME UP?

(2) HAVE ANY LIAKS GONE UP.

(3) SINCE THE LAST TIME NEGGEN WAS ENTEKED, WAS THE NOUE SATULATED?

AS IN FILCK, BA APPADPALATE STALUS MESSAGE IS SENERATED?

SITTLALLY IF ANY OF THE ANSWERS TO THE APOVE CONTITIONS IS YES.
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REMAILE IS ENTERED PERIODICALLY EVENY AUR MISEC TO RECALCULATE

GENERATE UNLY 1 PACKET TO INITIALIZE THE SURS. ALINIT, P1, F2, F3, P., P2, P1 ALININ, P1, P2, P3, P4, F5, P1, ALCC+0, P1, F2, P3, P1, F5, P1 ALKI BL, P1, F2, P3, P1, F5, P1 ANINIT, P1, P2, P3, P4, P5, P5 ANINIO, P1, F2, P3, P4, P5, P6 ANCONU, P1, P2, P3, P1, P7, P7 ANINITAL, P1, P2, P3, P2, P1 GENERATE TAPPASSE A 4U R. WS **トライモンは** HELPS HELPS HELPS

FT. DETRICK

7. <u>1 </u>	•	•	Section 6 + CJD	•
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	•		CODE FOR CLIRY INTO SOMIECTIVITY	

FOR THIS SIMULATION, CONN-CHANGE IS USED TO CHANGE THE STAIDS

OF FAULKS DA LINES DIPENDING ON THE COUR BELOW.

FOUR THINK LUSS, A SAVEVALUE FOR A FARLECULAR NODE IS SET HITH THE

LINK A IN MALCH A PARTICULAR I DUNK IS 10 BE CHANGED. GAUTHER SAVE
VELUE TS SET AS A FLAG TO NGOP THE TRUNK ON ADD.

(HT TRUNK BACK IT 146 FLAG IS ON ON THE SAVEVARUE.

10. LIYK LOSS, ANDTHER SAVEVARUE.

10. LIYK LOSS, ANDTHER SAVEVARUE.

10. LIYK LOSS, BAUTHER SAVEVARUE.

11. LIYK LOSS, BAUTHER SAVEVARUE.

12. LIYK LOSS, BAUTHER SAVEVARUE.

13. LATEL SAVEVARUE.

14. LIYK LOSS, BAUTHER SAVEVARUE.

15. LATEL SAVEVARUE.

16. LIYK CHANT THE SAVEVARUE.

17. LIYK LOSS, BAUTHER SAVEVARUE.

18. LATEL SAVEVARUE.

18. LASSEN TO BE SAVET TO SISHAL THE PARTICULAR TYPE OF PROCESSING THE ADMINISTICATION ON ON SAVE STATIONARY OF SAVEY SAVEVARUE.

18. LATEL SAVEVARUE.

18. LATEL SAVEY SAVE TO SAVET THENEFORE.

18. LATEL SAVEY SAVE TO SAVET SAVET THENEFORE.

18. LATEL SAVEY SAVE TO SAVET S

1.14 EYAMPLE - OROP YOUE -1. H.TS.CK FROM THE NEIMURK.

25JIL,,257L2,1,,)F GEN, 1 FAUCKL) 23 SECONDS INTO SIMULALION.
2 2.2 3EF FAPARITLA 2 WITH THE PAUKET PRIORITY.
3,3 5FF FAFA, 8 WITH THE SPECIAL STAF, PKI, LLNGTH 1,5ECPO SEVO COPY FUR F1,0EIRICK PRUCE,5ING. TO SEL IF STAL. MOG. IS NEGESSARY.
NEW LOPY FOR AUDICANS PROSESSING.
SET FLAS FOR LINK CHANGE.
SET FLAG FOR BAD NEWS PROJECTSING.
SET FLAG FOR FT. DETRICK'S LOSS. GC DEE IF STATE MSG. AS ALDESSARY. SEAN COPY FOR MANLOCK PROJESSING. SET FLAG FOR LINK CHANGE.
SET FLAG FOR GAP NEWS PROCESSING.
FLUG TO DROP LINK.
OKOP LINK 2 AT MLRANY. SET NUMBY FLAG FUR ALBANY'S LINK. GO DRUP THE NODE. GO DON LINK. 127,4, XL 060P LINK ALUCHG, P1, P2, P3, P1, 1, 2, P1 0 LLC46, P1, F2, P3, P4, P5, P5 121,1,XL 122,1,XL 125,c, XL Licolox 14.19.19.XL 146,1,XL 1+1 , 1 , XL AYD SC. THOUSE T ALCAR , Dr. 1 11 53V 5VALUE 53V 7VALUE SAVIVALUE HELDE SAVIVALUE TAVIVALUE GENERALE PRIJATIY SAVEVALUE SAVEVALUE SAVEVALUE 1 to 15 F ?? T \$4.45 F.7.2 455169 201001 SECPO SECPA

135,1,XL

131,1,XL

131,1,XL

135,0,XL

135,0,XL

136,2,XL

136,2, 193273 101919XL SET FLAG FOR LINK CHANGE. 101919XL SET FLAG FOR BAD NEWS PROCESSING. 10192XL FLAG TO DRUP LINK. 10192XL DRUP LINK 2 AT HANDUCK. 4407463P192933P19F19F GO DRUP LINK. 9AA441 SSNU GOPY FOR TIMEN PROCESSING. 1959,19XL 0030 11NK 1 41 GENTILE. GENCHU, P1, F2, P3, P5, P5, P5 60 OnUP LINK. GENCH 50 SET : F STAIL MSG. IS NEGESTARY. 1909,19XL SET FLAG FOR LINK CHANGE. 1919,19XL SET FLAG FOR SAU NEWS PROJESSING. 1909,50,XL FLAG 10 0NOP LINK. TICCHÚ, PI, P2, P3, P4, P5, P7 GO DKOP LINK.
JINHI GO SEL IF SIAI. MSS. IS NECESSARY. SET FLAS FOR LINK SHANGE. SET FLAG FOR FAL NEWS PROCESSING. FLAG TO UROP LINK. DAJP LINK 3 HT TINKER. 15 5 1 9 XL 13111XL 1 > 5 > 3 9 XL 37,3 XL SAVEVALUE HELPC TRAUSFER SAVEVAL IE 54V 1VE 19E 54VIV1_19E SAVIVALUE BULSVEVES SAVTVALUE 3445445 シャン・シャントリミ BULLATUR SAVEVALUE SAVETALUE SAVIVALUE **ミセン・マント**シ 1 38 45 FF 2 434 17 47 I 1.24.45F SECPG SPLIT SECPH SELPE

RESTORE THE FIR DETRICK NOSE TO OPERALLONAL CAPABILITY.

'POUDD', +6512,1,, F GEN. 1 PACKET +6 SECONDS INTO SIMULATION.

2.2

SET PARNHETER 2 WITH PRIORITY.

3, 3

SET PLAN. 3 WITH SPECIAL STAT. 456. LENGTH.

1, SECP1

SEND COPY FOR FT.DETRICK PROCESSING. 121,1,XL SEI FLAG FOR LINK CHANGG.
122,0,XL SEI FLAG FOX GOUD NEWS PROCESSING.
120,1,XL FLAG TO AJO LINK BACK.
4 LCJHG,P1,P2,P3,P4,F5,PU GO ADO LINK.
9 ALMAL
1,SEUP2 SEND COPY FOM ANDAGMS' PROCESSARY. 5 2L 21 SAV 3VLUE SAV 3VLUE SAV 3VLUE HEL 3 T AN 45 FE S SEUPT SPLIT GENCRATE FRL JOLFY ASS TON ASSESA

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TERMINATE THIS TIME PERIOD.

19.NP

KUN FCK U SEC. 10 BYPASS MEIMONT INIT. STATS

50.93

30.93

30.93

26.FETIMS1, DIALQUI-0.11403 MAPE OUT INIT. STATS

50.93

26.FNAEXPON, 10.95

6 FEN. PACKETS A DUX SAT. - MEAN DF 26 MSEC.

11.84 FNAEXPON, 10.95

6 EN. PACKETS A DUX SAT. - MEAN DF 26 MSEC.

11.87 FNAEXPON, 10.95

6 EN. PACKETS A DUX SAT. - MEAN OF 10 MSEC.

22.FNAEXPON, 10.95

6 EN. PACKETS A DUX SAT. - MEAN OF 12 MSEC.

22.FNAEXPON, 10.95

6 EN. PACKETS A DUX SAT. - MEAN OF 32 MSEC.

31.FNAEXPON, 10.95

6 EN. PACKETS A DUX SAT. - MEAN OF 31 MSEC.

31.FNAEXPON, 10.95

6 EN. PACKETS A DUX SAT. - MEAN OF 31 MSEC.

31.FNAEXPON, 10.95

6 EN. PACKETS A DUX SAT. - MEAN OF 31 MSEC.

31.FNAEXPON, 10.95

6 EN. PACKETS A DUX SAT. - MEAN OF 31 MSEC.

31.FNAEXPON, 10.95

5 EN. PACKETS A DUX SAT. - MEAN OF 31 MSEC.

41.FNAEXPON, 10.95

41.FNAEXP
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                                                                                                                                                                                                               SET FLAG FON LINK CHANGE.
SET FRAG FOW GOOD NEWS PRUCESSING.
                                                 MESET FLAG FUN DETRICK'S RETURN-
GO SEE IF STAT. MSG. IS NUCLSSARY.
SENN CUPY FUN HANGUCK PROCESSING.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                       196,1;XL
FLAG 10 AND LINK BAUK.
IICCHG,P1,P2,P3,P., GU AND LINK.
FILMH GO SEE JF STAT. MSG. IS NECESSARY.
                                                                                                                                 SET FLAG FOR LINK CHANGE.
SET FLAG FUR GOOD NEWS PRODESSING.
FLAS TO ADD LINK BACK.
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Section 7

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19.1
79, FN. EXPON., 19. F GEN. PACKLIS 3 20% SAT. - HEAN OF 79 HSEC. 20, FN. EXPON., 19. F GEN. PACKLIS 3 20% SAT. - HEAN OF 79 HSEC. 223, FN. EXPON., 19. F GEN. PACKLIS 3 20% SAT. - HEAN OF 72 HSEC. 23, FN. EXPON., 19. F GEN. PACKLIS 3 20% SAT. - HEAN OF 323 HSEC. 21, FN. EXPON., 19. F GEN. PACKLIS 3 20% SAT. - HEAN OF 323 HSEC. 27, FN. EXPON., 19. F GEN. PACKLIS 3 20% SAT. - HEAN OF 77 ASIC. 32, FN. EXPON., 19. F GEN. PACKLIS 3 20% SAT. - HEAN OF 72 MSIC. 32, FN. EXPON., 19. F GEN. PACKLIS 3 20% SAT. - HEAN OF 32 MSIC. 52, FN. EXPON., 19. F GEN. PACKLIS 3 20% SAT. - HEAN OF 32 MSIC. FLALPSI-FEITHSI, 0741CUI-77IANO3 HIPL OUT 10% SINI. STAIS
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20% SAT., THEN PAIN
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FJALPS1-FILIS1, DSALDU1-01T1M33 RESEL STATS EXDEPL THESE.

19.1
FJALPS1-FILIS1, 013LQU1-01T1M33 RESET STATS EXDEPL THEM PALMI STATS
FJALPS1-FILISS1, 013LQU1-01T1M33 RESET STATS EXDEPL THESE.

19.1
END FUR 1 SFC @ 20% SAT., THEM PRINT STATS
END THIS DUMPLELE SIMULATION EXEKCISE.

START START START START Appendix E

Listing of SAVEVALUES

Albany

SAVEVALUE					Reason for Use
1	Length	of	output	queue	ALQ11
2	**	*	•	•	ALQ21
3	**	*	•	•	ALQ22
4	**	n	**	•	ALQ23
5	•	*	•	"	ALQ31
6	#	**	•	**	ALQ32
7	Ħ	•	•	**	ALQ41
57 - 64			tatus ir matrix		on (Albany's row
121	Link ch		ge flag	if non-	zero, trunk change
122	MESGEN	en	try flag	g, 0 - S	TICK, 1 - FTICK
123	Length	of	input o	lueue	ALQUL
124	#	**	•	*	ALQU2
125				sage ge isg gene	neration flag, rated
126	Trunk/1	Lin	c change	flag,	0 - drop, 1 - add
127	Link nu	ımbe	er in wh	nich cha	nge is to occur

Andrews

SAVEVALUE					Reason for Use
8	Length	of	output	queue	ANQ11
9	•	*	11	H	ANQ21
10	**	*	•	•	ANQ22
11	*		**	Ħ	ANQ31
12	W	Ħţ	•	#	ANQ41
13	•	•	•	**	ANQ42
65 - 72	Network of LD m			nformati	on (Andrews' row
130	Link ch			if non-	zero, trunk change
131	MESGEN	ent	ry flag	, 0 - S	TICK, 1 - FTICK
132	Length	of	input q	ueue	ANQUL
133	**	*	•	•	ANQU2
134				sage ge isg gene	neration flag, ration
135	Trunk/1	Link	change	flag,	0 - drop, 1 - add
136	Link m	ımbe	r in wh	ich cha	nge is to occur

Ft. Detrick

SAVEVALUE				Reason for Use
14	Length of	output	queue	DEQ11
15	10 10	•	•	DEQ12
16	• •	•	•	DEQ13
17		Ħ	*	DEQ21
18	н и	n	**	DEQ22
19	B1 69	40	**	DEQ31
20	n n	n	••	DEQ32
21	11 44	89	•	DEQ33
22	**	11	**	DEQ41
23	11	n	11	DEQ42
24	• •		"	DEQ51
25	61 44	•	••	DEQ52
73 - 80	Network st			n (Ft. Detrick's
140	Link chang	ge flag	if non-ze	ero, trunk change
141	MESGEN ent	ry flag	, 0 - ST	ICK, 1 - FTICK
142	Length of	input q	ueue	DEQUI
143	n n	*	•	DEQU2
144	H 11	*	•	DEQU3
145	MESGEN sta 0 - no mse	tus mes	sage gene essage ge	eration flag, enerated
146	Trunk/Link	change	flag, 0	- drop, 1 - add
147	Link numbe	r in wh	ich chan	ge is to occur

<u>Gentile</u>

SAVEVALUE	Re	ason for Use
26	Length of output queue	GEQ11
27	. и и и	GEQ12
28	PF 17 M 15	GEQ13
29	FI 11 II 17	GEQ21
30	61 91 M PF	GEQ31
31	\$1 91 91 94	GEQ32
32	99 19 59 11	GEQ41
33	н н н	GEQ51
34	11 11 11 11	GEQ52
81 - 88	Network status information (row of the LD matrix)	Gentile's
150	Link change flag if non-zero if zero	, trunk change
151	MESGEN entry flag, 0 - STICK	, 1 - PTICK
152	Length of input queue	GEQU1
153	PI 16 PI PI	GEQU2
154	MESGEN status generation fla l - msg generated	g, 0 - no msg,
155	Trunk/Link change flag, 0 -	drop, 1 - add
156	Link number in which change	is to occur

Hancock

SAVEVALUE					Reason for Use
35	Lengtl	of	output	queue	HNQ11
36	m		**	••	HNQ21
37	•		*	•	HNQ22
38	11	**	**	•	HNQ31
89 - 96			atus i matrix		n (Hancock's row
160	Link of zer		e flag	if non-z	ero, trunk chnage
161	MESGE	N ent	ry fla	g, 0 - ST	ICK, 1 - FTICK
162	Length	of	input	queue	HNQUE
163	MESGI 0 - 1	EN st	atus m g, 1 -	essage ge msg gene	neration flag, rated
164	Trunk	c/Lin	k chan	ge flag,	0 - drop, 1 - add
165	Link	numb	er in	which cha	nge is to occur

<u>McClellan</u>

SAVEVALUE					Reason for Use
39	Length	of ou	tput	queue	MCQ11
40	**	54	w	••	MCQ12
41	n		••	**	MCQ21
42		••	**	•	MCQ31
43	H	••	•	**	MCQ32
97 - 104	Network row of				on (McClellan's
170	Link ch		flag	if non-2	ero, trunk change
171	MESGEN	entry	, flag	g. 0 - S1	PICK, 1 - FTICK
172	Length	of in	nput q	lueue	MCQUL
173	"	*	er	**	MCQU2
174				sage ger isg gener	neration flag,
175	Trunk/I	Link o	hange	flag, C) - drop, 1 - add
176	Link nu	umber	in wh	ich char	nge is to occur

Norton

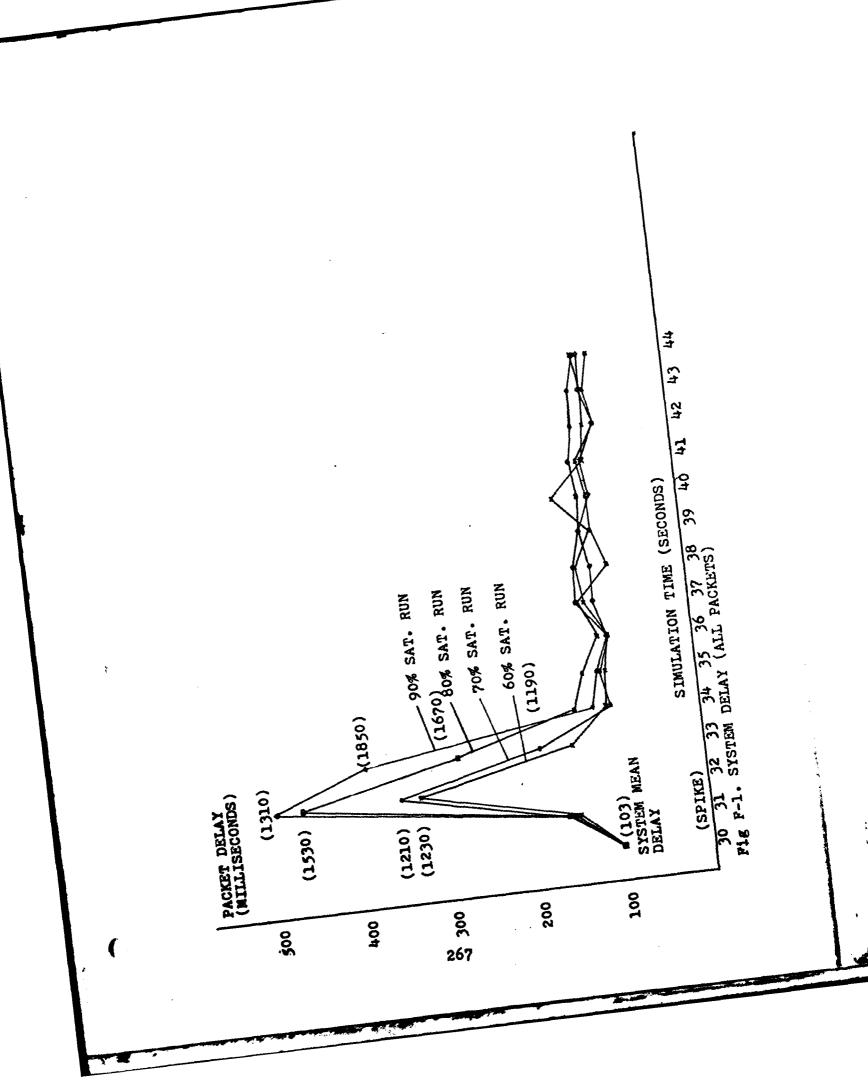
SAVEVALUE					Reason for Use
44	Length	of (output	queue	NOQ11
45	••	**	н	11	NOQ12
46	n	*	w	**	NOQ21
47	••	•	**	•	NOQ31
105 - 112	Network				nformation (Norton's
180	Link ch		e flag	if non-	zero, trunk change
181	MESGEN	enti	ry flag	g, 0 - S	TICK, 1 - FTICK
182	Length	of i	input q	lueue	NOQUE
183				sage ge isg gene	neration flag, rated
184	Trunk/I	ink	change	flag,	0 - drop, 1 - add
185	Link nu	mbei	r in wh	ich cha	nge is to occur

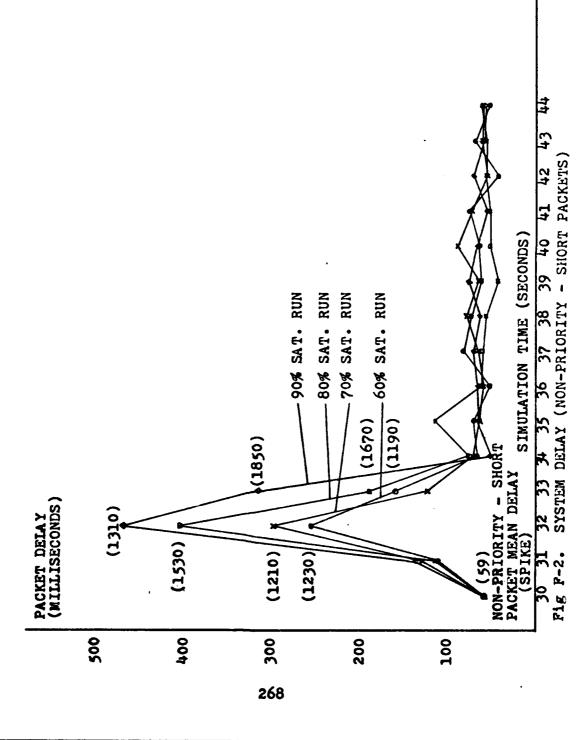
<u>Tinker</u>

SAVEVALUE					Reason for Use
48	Length	of o	utput	queue	TKQ11
49		**	н	**	TKQ21
50	Ħ	n	11	n	TKQ22
51	n	•	w	01	TKQ31
52	**	11	11	41	TKQ32
53	**	n	**	# .	TKQ41
54	н	**	11	**	TKQ42
55	01	н	11	**	TKQ51
56	Ħ	**	14	H	TKQ52
113 - 120	Network of the				on (Tinker's row
190	Link chif zero		flag	if non-	zero, trunk change
191	MESGEN	entr	y flag	g, 0 - S	STICK, 1 - FTICK
192	Length	of i	nput q	ueue	TKQU1
193	н		10	81	TKQU2
194	# ·	**	••	94	TKQU3
195				sage ge	eneration flag, erated
196	Trunk/I	Link	change	flag,	0 - drop, 1 - add
197	Link n	ımber	in wh	ich cha	inge is to occur

Appendix F

Graphical and Tabular Delay Results
From the Fully Operational Network





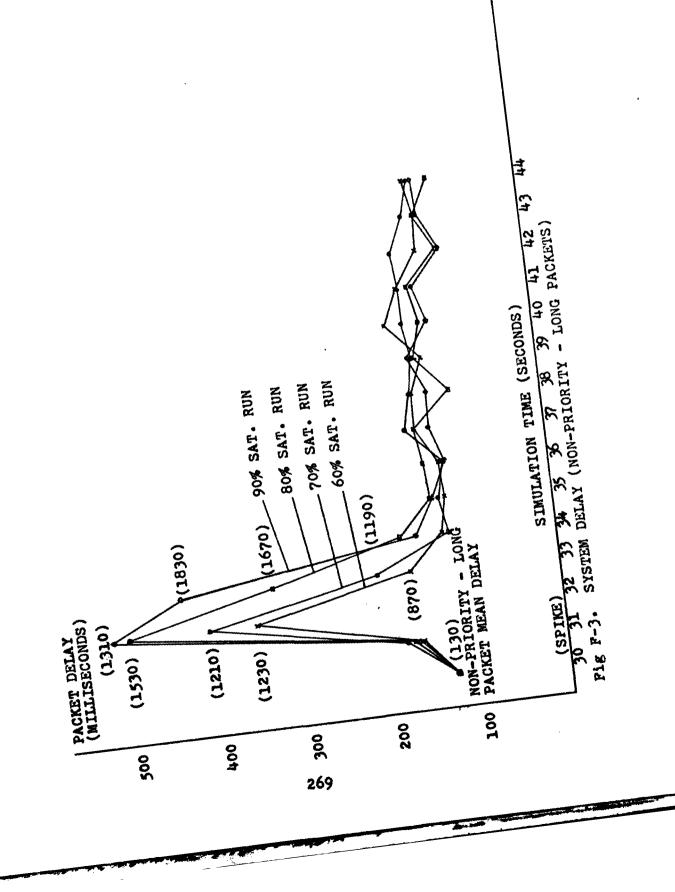


TABLE F-I

System Delay (priority - short packets)

Simulation Time	60% Sat.	Delay Run	Times (milliseconds) 70% Sat. Run 809	11isecon Run	nds) 80% Sat.	Run	90% Sat.	Run
(seconds)	Mean	Max	Mean	Max	Mean	Max	Mean	Max
30	99	230	99	230	99	230	99	230
31 (spike time)	ı	,	45	45	%	110	87	8
32		ı	•	1	8		65	130
33		123	ı	1	62	29	33	33
34	33	33	1	ı	6	٣	ı	1
35		125	•	1	ı	ı	ı	•
36	62	20	89	89	1	,	63	63
37	t		38	38			1	•
38	17	17	77	77	•		1	1
39	~	6	1	ı	t	•	18	30
. 017	ı	•	ı	•	ı	ı	ı	•
14	•	•	ı	t	ı	•	1	ı
715	ı	ľ	ı	•	63	63	ı	ı
43	33	33	1	•	•	1	ı	١
71		ı	•	ı	~	٣	85	85

TABLE F-II

System Delay (priority - long packets)

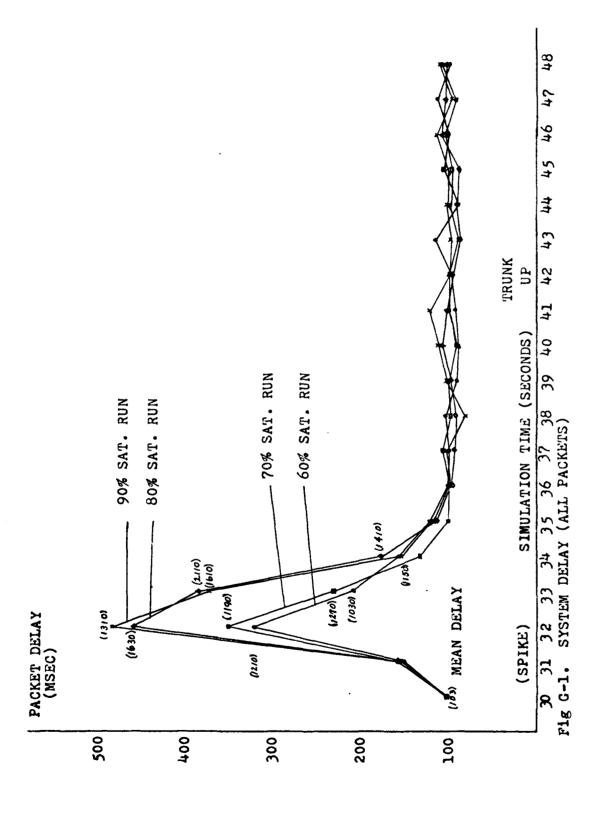
Simulation		Delay	Times (milliseconds)	llisecond	(s)			
Time	60% Sat.	Run	70% Sat.	Run	80% Sat.	Run	90% Sat.	Run
(seconds)	Mean	Max	Mean	Max	Mean	Max	Mean	Max
30	122	250	122	250	122	250		250
31 (spike time)	101	250	215	270	165	310		250
32	9	9	215	215	119	119	99	130
33	108	210	ı	1	139	139		110
34	ı	•	1	•	223	223		310
35	159	210	107	107	ŧ	ı	٠	901
36	55	110	ı	ı	23	210		9
37	205	205	•	•	21.5	230		ı
38	ŧ	ı	222	310	62	130		107
	52	110	75	150	209	509	797	564
0†7	150	210	ı	•	901	901		901
41	ı	ŧ	•	•	211	211		س
75	124	174	ŧ	ı	509	509		ı
643	t	ı	160	210	65	130	•	ı
ग ग	1	1	1	1	87	110		270

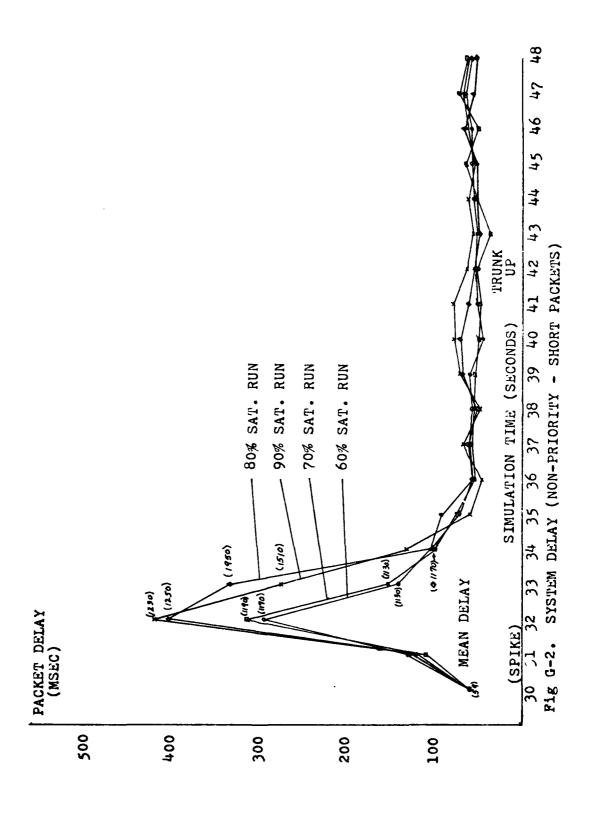
Appendix G

Graphical and Tabular Delay Results

From the Trunk Loss Runs

Albany - Ft. Detrick Trunk Loss





AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOO--ETC F/6 17/2 AN ANALYSIS OF A ROUTING ALGORITHM FOR AUTODIN II.(U) DEC 79 JA MHITTENTON AFIT/06/5/EZ/79-18 AD-A080 484 UNCLASSIFIED 4∾5

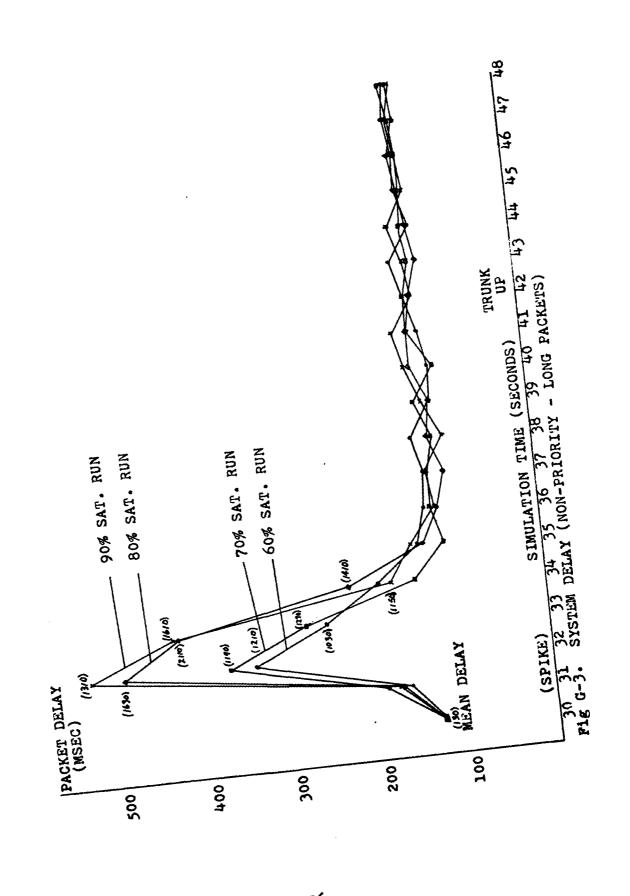


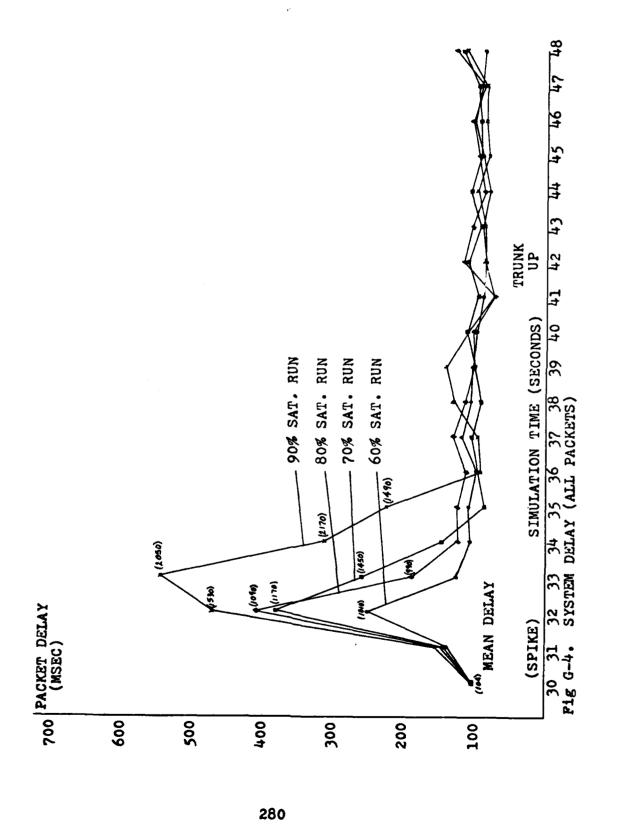
TABLE G-I System Delay (priority - short packets)

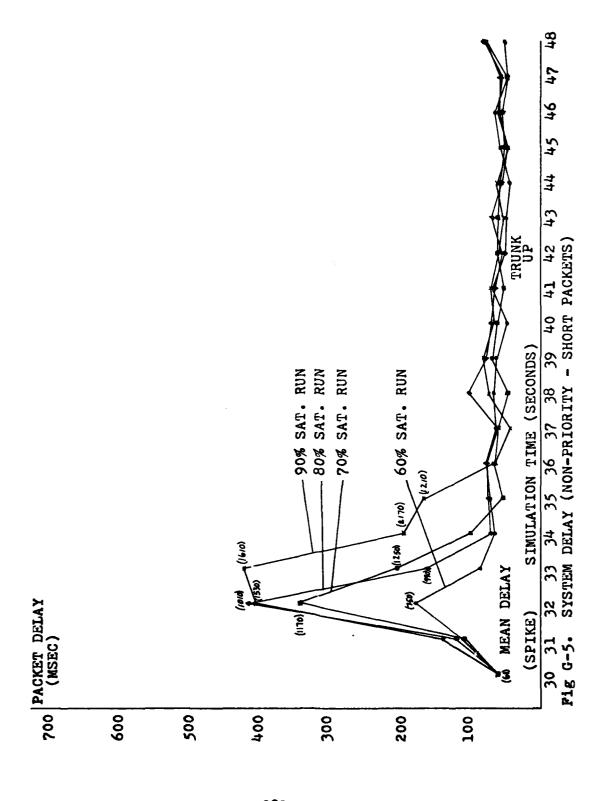
Simulation	•	Delay	Times (m	1111880	onds)			
Time (seconds)	60% Sat. Mean	Run Max	70% Sat. Run 80% S Mean Max Mean	Run Max	80% Sat. Mean	Run Max	90% Sat. Mean	Run Max
30	99	230	99	230	99	230	99	230
31 (spike time)	1		ı	ı	152	250	719	90
32	ı	ı	130	130	1	•	•	ı
33	ı	•	89	110	35	35	117	117
34	33	33	1	1	136	136	33	33
35	ı	•	1	ı	9	6	†1	20
36	18	30	58	20	ı	1	ı	1
37	ı	•	117	130	29	29	•	ı
38	1	1	•	t	0 †	040		1
39	ı	ſ	•	ı	1	•	,	1
04	715	77	124	124	•	ı	1	1
11	1	ı	1	ı	142	142	•	1
42 (trunk up)	1	ı	1	ı	706	106	•	ı
64	1	i	35	35	36	36	~	9
717	ı		1	ı		ı	33	33
4.5	1			ı	51	20	•	47
94	33	33	33	33	ı	ı	47	180
44	t	ŧ	57	80	24	42	160	35
847	1	ŧ		1	٣	3	35	

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f
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		747						
	System Delay (priority	lay (pri		- long packets	kets)			
mulation Time seconds)	60% Sat.	Delay Run Max	Times (m. 70% Sat.	(milliseconds) t. Run 80% Max Mean	nds) 80% Sat. Mean	Run Max	90% Sat.	Run Max
30	122		122	250	122	250		250
31 (spike time)	101	250	•	1	19	90		250
32	9	9	159	210	9	10		350
33	6	٣	111	111	566	566	351	351
34	218	230	55	110	3	٣		130
35	1	ı	154	154	208	310		ı
36	ı		106	901	~	3	.1	1
37	ı				126	250	ı	1
38	69	130	183	210	101	190	901	106
39	178	250	154	310	55	011	•	1
017	1		159	210	209	509		1
Ιη	ı		164	164	102	190	159	210
42 (trunk up)	80	89	ı	1	36	20	1	1
43	106	106	•		•	ı	ς,	3
ग ग	706	901	1	ŧ		1	106	901
45	1	1	ı		215	290	ı	ŧ
94	706	901	901	706	•		291	291
24	99	99	•	ı	71	17	150	190
847	ı	1	81	81	213	213	37	37

Andrews - Tinker Trunk Loss





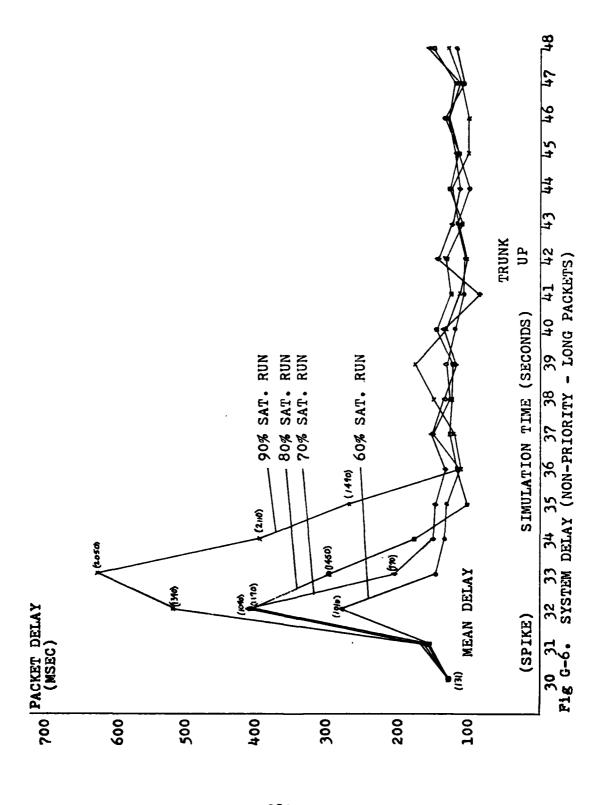


TABLE G-III

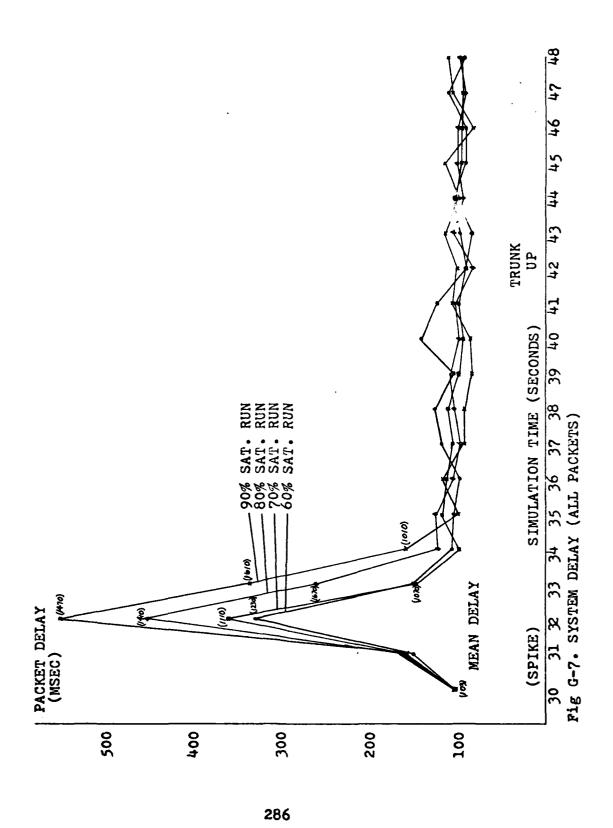
System Delay (priority - short packets)

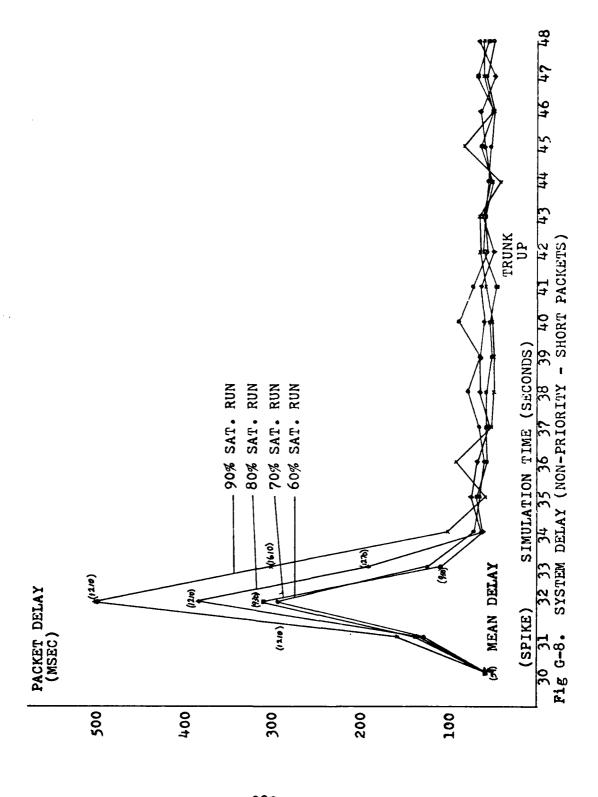
Simulation	•	Delay	Times (m	illisec	onds)	1	· · · · · · · · · · · · · · · · · · ·	•
Time (seconds)	60% Sat. Mean	Run Max	70% Sat. Mean	Kun Max	70% Sat. Kun 80% Sat. I Mean Max Mean N	Kun Max	yo% sat. Mean	Kun Max
30	72	230	72	230	72	230	72	230
31 (spike time)		96	647	90	99	150	73	130
32		ı		ı	847	50	103	103
33		•	29	170	ı	t	ı	ı
34		50	145	145	ı	1	m	~
35		33		1	04	20	1	ı
36	1	•	017	017	108	110	29	62
37	1	ı	•	1	63	20	1	t
38	87		1	1	39	39	1	ı
39	•		٣	٣	77	22	ſ	t
. 04	ı		,	ı	•	•	1	ı
14		ı		ı		1	09	9
42 (trunk up)	1		ı	ı	1	1		ı
43	٣		i	ŧ	•	1	1	1
44	1		37	37	33	33	35	35
4.5	1		73	23	•	1	1	•
911	18		٣	٣	1	•	ı	1
47	35		1	1	131	131	1	t
847	103		9	٣	ı	1	1	•

TABLE G-IV System Delay (priority - long packets)

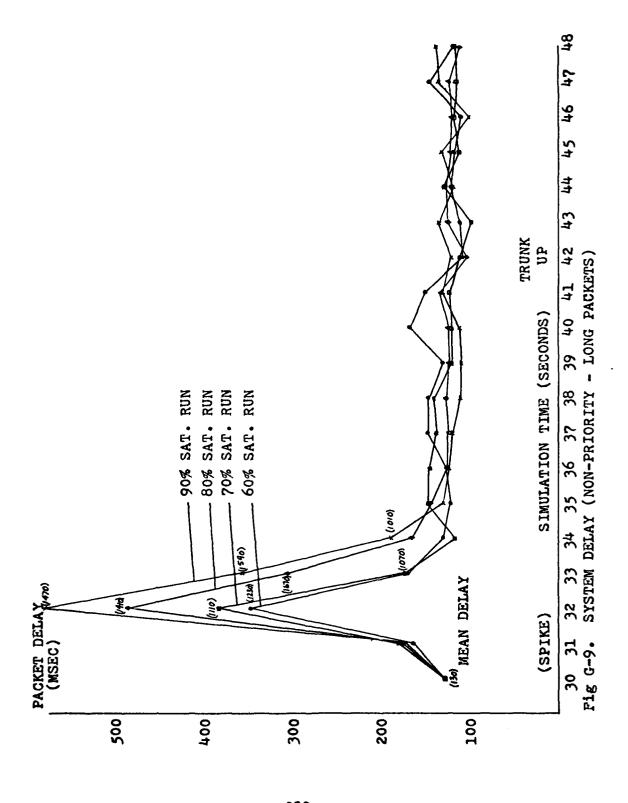
		,	•	ı	•		•			
Simulation Time (seconds)	tion ? ids)	60% Sat. Mean		Delay Run Max	Times (milliseconds) 70% Sat. Run 80% Mean Max Mea	illiseco Run Max	onds) 80% Sat. Mean	Run ' Max	90% Sat. Mean	Run Max
30		122	250	0	122	250	122	250	122	250
31	(spike time)	168	250	0	138	290	26	210	95	210
32		359	359	6	1	1	205	330	115	115
33		í	1	1	19	170	72	130	37	37
34		ı	t		٣	9	197	230	ı	ı
35		108	210	0	131	131	•	1	259	259
36		55	110	0.	س	٣	ı	ı	72	150
37		ı	•	1		•	509	209	•	1
38		185	210	0	357	357	٣	3	٣	٣
39		1	1	ı	23	110	ı	ı	1	ŧ
40		61	110	0	298	298	117	130	1	1
14		•	•		149	149	901	901	ı	ı
42	(trunk up)	706	10	901	109	109	1	ı	ł	•
43		146	14	9	901	106	٣	8	1	ı
77		222	22	222	•	ı	ı	1	109	109
45		ı	ı	ı	73	210	•	ı	106	706
94		3		ν.	110	110	í	ı	•	1
24		3		٣	182	182	1	•	•	1
847		1	•		•	ı	•	ı	ı	•

Ft. Detrick - Tinker Trunk Loss





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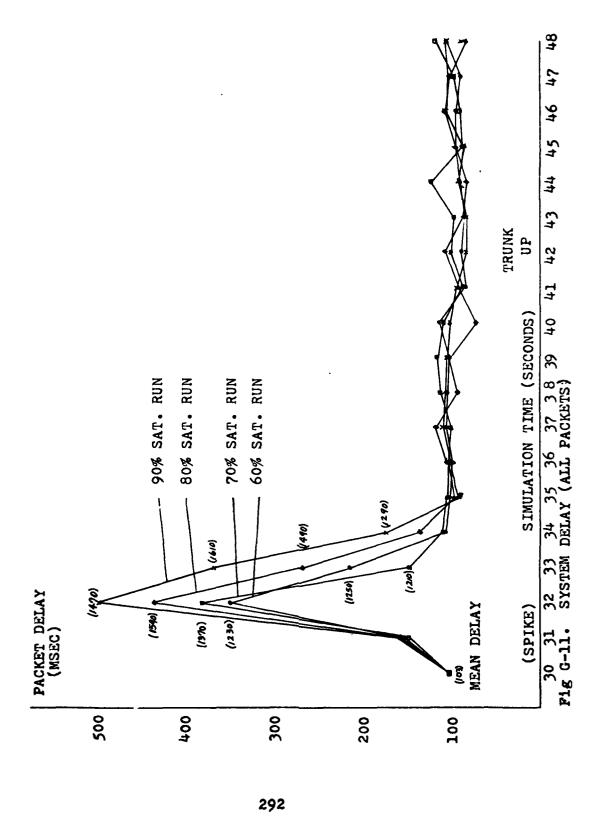
	System Delay (priority	lay (pr	lority -	short packets	ckets)			
Simulation Times (seconds)	60% Sat. Mean	Delay Run Max	Times 70% S. Mean	(milliseconds) at. Run 80% S Max Mean	onds) 80% Sat. Mean	Run Max	90% Sat. Mean	Run Max
30	99	230	99	230	99	230	99	230
31 (spike time)	1		19	20	1	ı	56	110
32	1	1	1	ı	36	36	ı	ı
33	123	123	r	ı	33	33	•	•
34	33	33	1	ı	•	ı		1
35	125	125	3	٣	ı	ı	27	20
36	62	20	14	41	107	107	62	8
37	ı	ŧ	1	1	63	63	•	ı
38	71	17	1	1	ı	ı	٣	~
39	٣	Μ	1	ſ	1	1	•	•
04	ı	1	•	ı	ı	ı	•	•
	ı	f	i	ŧ	i	1		•
42 (trunk up)	98	98	1	ı	1			1
64	ı	ı	•	ı	٣	٣	1	
† †	j		1	ı	706	210	•	1
45	9	110	34	₹	130	130	75	90
947	137	137	ŧ	1	33	33	•	•
24	33	33	i	t	45	50		•
847	ı	ı	3	٣	•			•

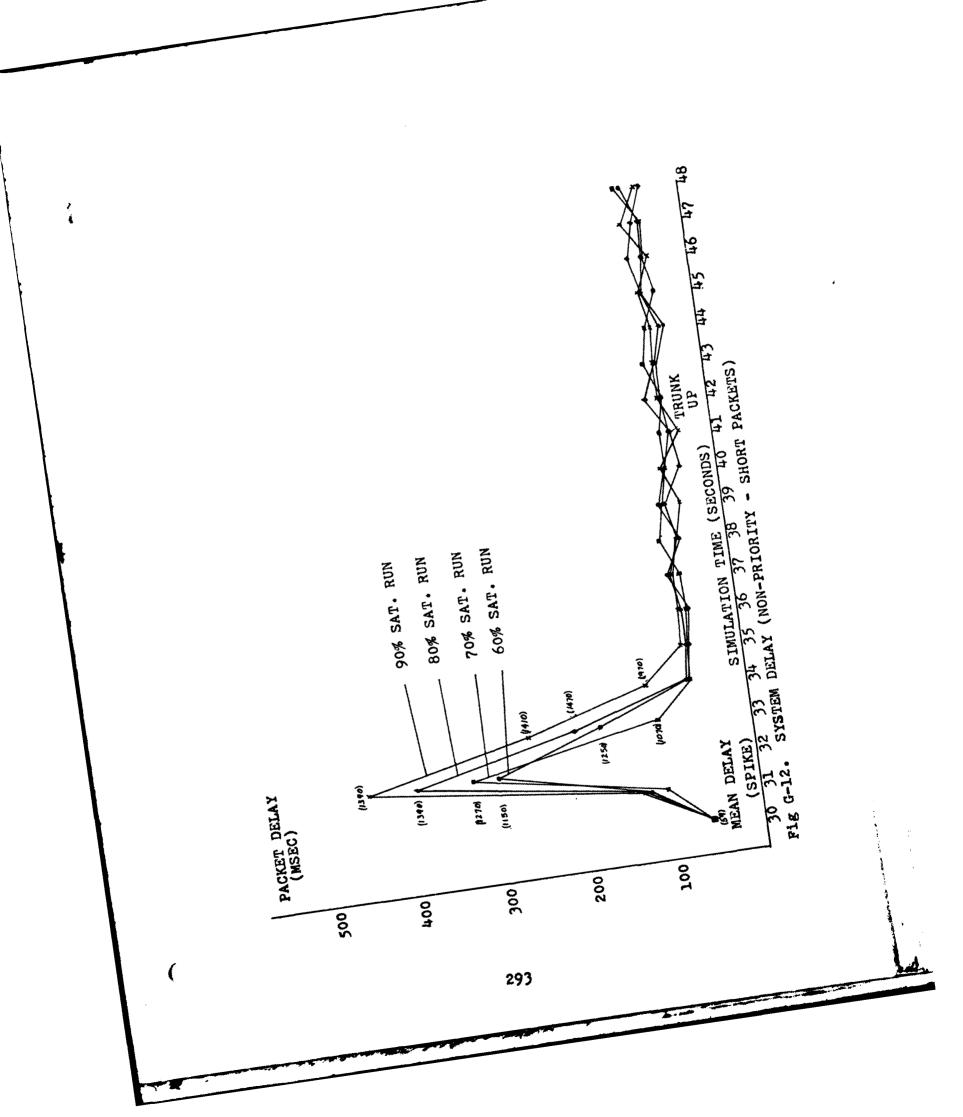
TABLE G-VI

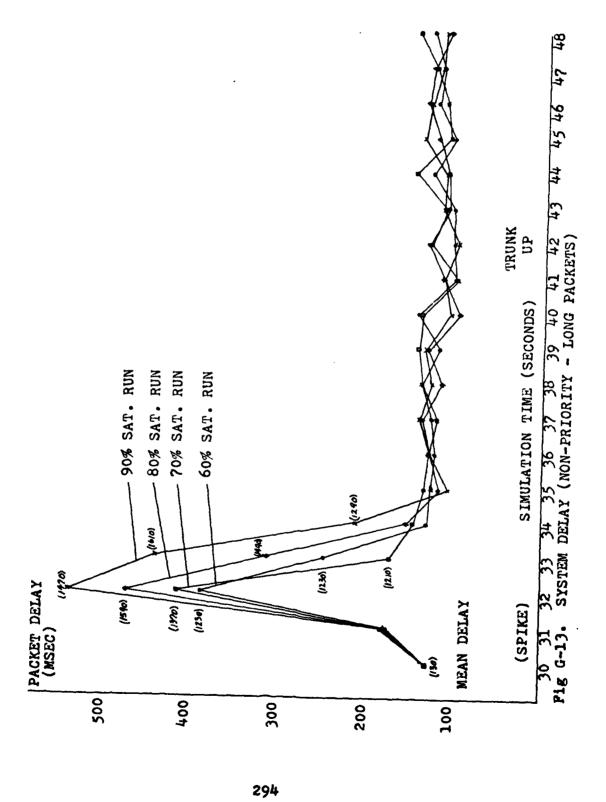
			4	יייים מייירישי				
		System De	elay (pri	System Delay (priority - long packets)	ong pac	re ts)		
Simulation Times (seconds)	ion s ds)	60% Sat. Mean	Delay Run Max	Times (milliseconds) 70% Sat. Run 80% Mean Max Mean	.llisecor Run Max	nds) 80% Sat. Mean	Run Max	90% Sat. Mean
30		122	250	122	250	122	250	122
31	(spike time)	101	250	202	250	177	310	163
32		٣	<i>د</i> ر	ı	ı	1	•	1
33		108	210	ς,	~	•		٣
34				257	257	2	ъ.	ι.
35		159	210	194	270			108
36		55	110	1	ı	169	169	143
37		205	205	1		137	190	
38		•	1	72	150	ı	ı	164
39		52	101	179.	230	ħ 6	190	152
04		150	210	116	116	901	901	1
141		ı		•	•	901	901	190
745	(trunk up)	183	183	29	130	٣	Μ	228
43		•	1	6	٣	77	†	•
77		233	233	167	210	120	120	85
45		٣	٣	152	310	ı	1	209
94		163	163	106	901	706	901	٣
47			1	59	90	~	٣	50
84		ı	•	1	ı	209	209	706

Run Max 250 250 250 250 - 3 108 210 152 - 5230 2230 2209 209 209 3 3 70 106

Gentile - Ft. Detrick Trunk Loss







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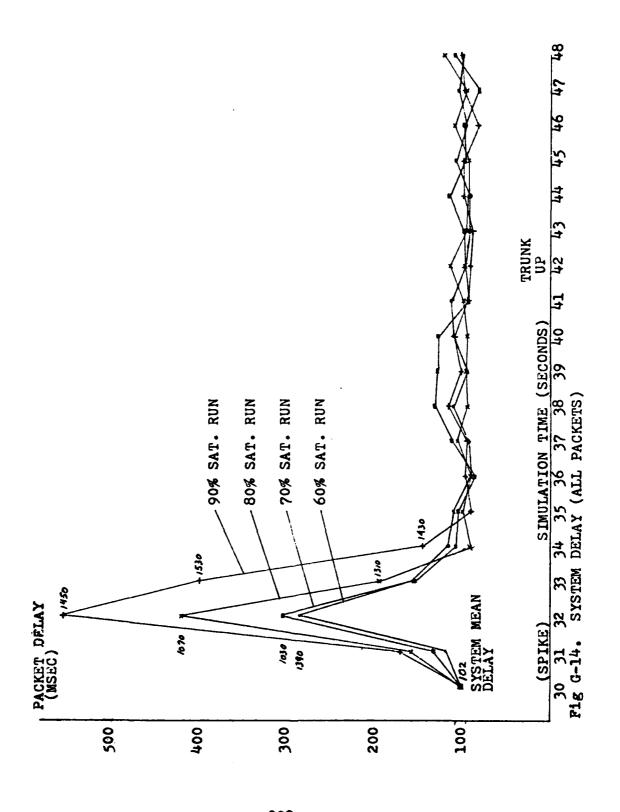
TABLE G-VII System Delay (priority - short packets)

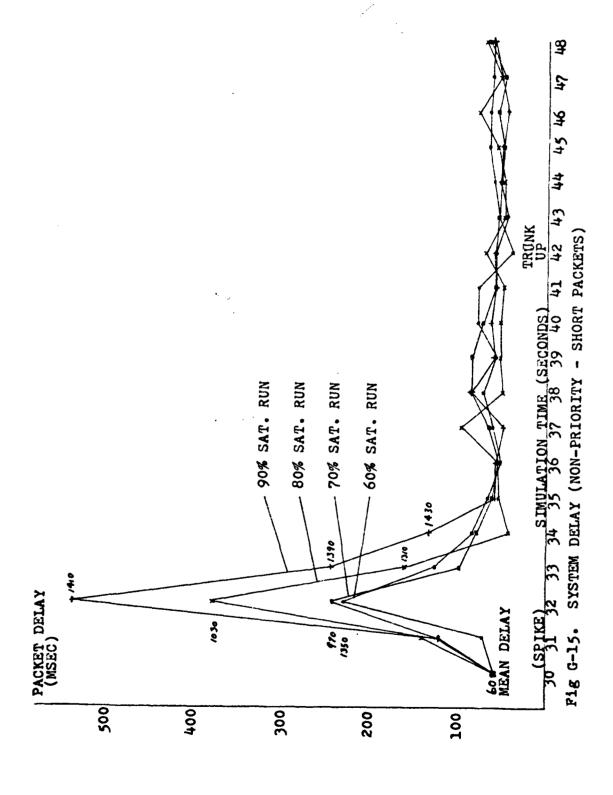
et mile 44 on			Deley	Times.	11115000	ทศิลา			
Time (seconds)		60% Sat. Mean	Run Max	70% Sa Mean	Run	t. Run 80% Sat.	Run Max	90% Sat. Mean	Run Max
30		99	230	99	230	99	230	99	230
31 (spike tim	time)	•	1	•	1	1		137	250
32		71	90	162	162	33	33	128	128
33		33	33	33	33	3	٣	152	190
煮		1	1	٣	~	14	14	173	173
35			ı		1	ω	80	76	130
36		•	ı	28	20	1	1	151	151
37		67	130	1	ı	89	89	•	•
38		ı	ı	35	35	1		108	110
39		ı	ı	33	33	Þ	ı	•	ı
04		2	٧	٣	3	38	38	ı	٠
11		,	ſ	1	•	1	ı	1	ı
42 (trunk up)	up)	ı	ı	33	33	ı	ı	1	1
43		18	30	1	1	•	1	63	20
##			1	1	ı	ī	1	45	67
45		71	71	63	63	•	ı	1	ı
94		2	2	1	•	24	50	•	•
24		63	63	33	33	18	30	16	170
847		1	ı	100	110	ı	1	ı	ı

TABLE VIII System Delay (priority - long packets)

Simulation		Delay	Times (m	(milliseconds)	uds)			
Times (seconds)	60% Sat. Mean	Run Max	70% Sat. Mean	Run Max	80% Sat. Mean	Run Max	90% Sat. Mean	Run Max
30	122	250	122	250	122	250	122	250
31 (spike time)	126	250	176	250	258	310	84	96
32	1	1	212	212	83	130	123	123
33	136	330	213	250	121	121	65	65
*	171	250	•	t	80	130	19	30
35	126	150	52	290		ı	ı	ı
36	•	ı	1	•	901	901	187	190
37	134	170	172	230	178	290	•	•
38	ı	1	1 79	130	106	106	,	1
39	143	150	217	270	29	330	80	150
04	106	106	1	ı	0	•	106	106
11	308	308	252	252	252	252	106	106
42 (trunk up)	•	t	149	250	110	110		ı
43	ı	ı	1	1	٣	٣	262	292
† †	٣	٣	1	•	1	•	133	190
45	ı	ı	145	210	176	176	1	ı
94	209	210	•	•	•	•	1	ı
24	1	•	•	ı	3	٣	106	106
84	ı	ı	•	1	109	109	119	130

Gentile - Tinker Trunk Loss





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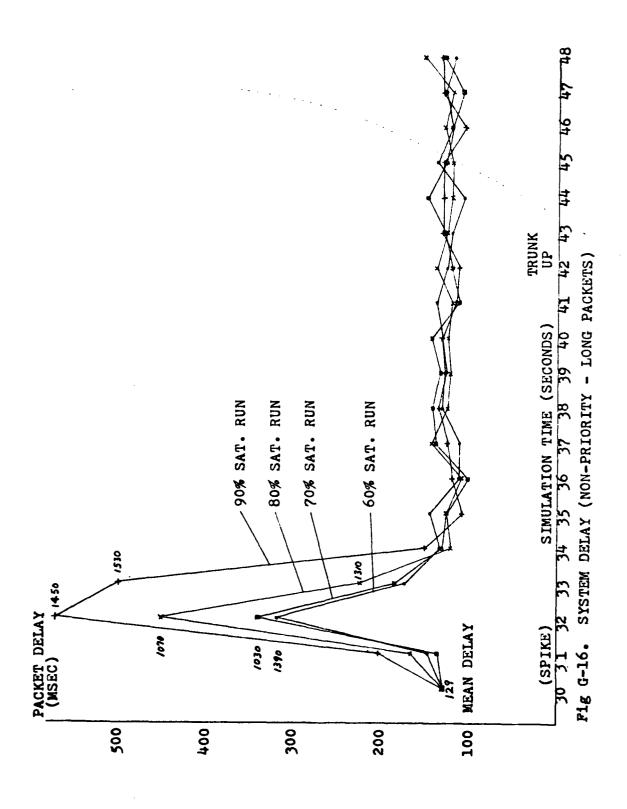


TABLE G-IX System Delay (priority - short packets)

Simulation Time (seconds)	60% Sat. Mean	Delay Run Max	Times 70% Sa Mean	nillisec Run Max	(milliseconds) t. Run 80% Sat. Max Mean	Run Max	90% Sat. Mean	Run Max
30	69	230	69	230	69	230	69	230
31 (spike time)	·	ı	94	96	48	130	18	30
32	ì	1	ı	•	•	ı	115	190
33	1	ı	ı	ı	ĸ٧	5	ı	•
34	ı	1	ı	ı	18	30	1	•
35	1	ı	ı	,	ı		33	33
36	ŧ	ı	6	σ	33	33	ı	1
37	ı	1	ı	ı	е	3	ŧ	•
38	1	i	33	33	156	156	33	33
39	64	64	1	i	٣	٣	33	33
04	84	20	103	103	ı	1	ı	•
41	3	٣	ı	ı	•	ı	3	3
42 (trunk up)	1	ı	•	•	ı	ı	i	ı
43	33	33	ı	ı	i	1	73	73
1717	ı	,	ı	ı	33	33	1	1
45	E	~	1	ı	63	63	m	3
, 94	33	33	ı	ı	33	33	1	•
24	3	6	13	30	1	1	33	33
847	33	33	1	ŧ	37	37	3	~

TABLE G-X System Delay (priority - long packets)

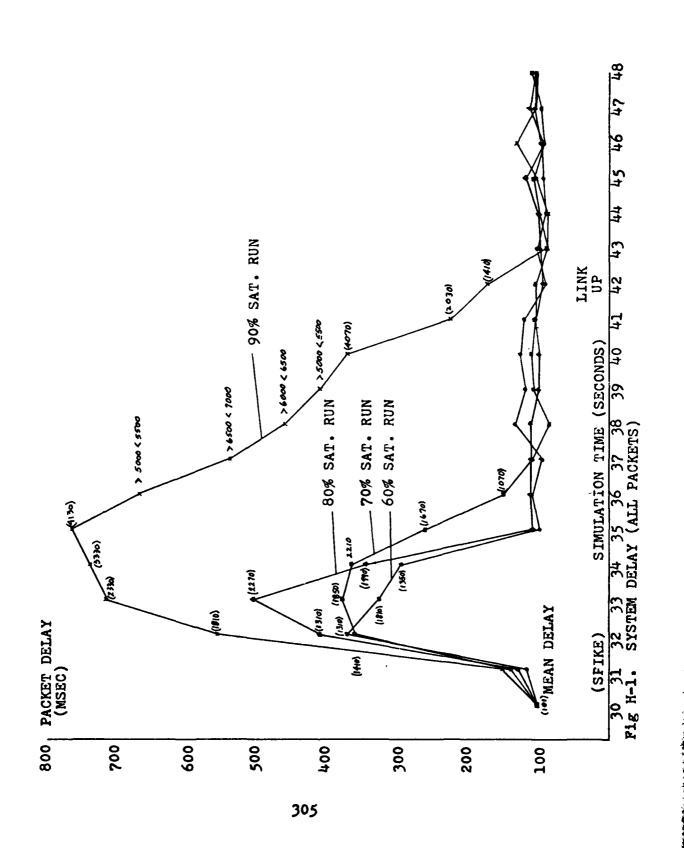
Simulation	60% Sa+	Delay Run	Times	• [4	nds) 80% Sat.	Run	90% Sat.	Run
(seconds)	Mean	Max	Mean	Max	Mean	Max	Mean	Max
30	110	250	110	250	110	250	110	250
31 (spike time)	103	190	193	290	135	250	156	320
32			•	1	109	110	111	210
33	139	310	109	109	120	270	ν,	2
*	171	210	ı	•	108	210	ı	ı
35	114	114	277	277	901	901	706	901
36	157	157	1	•	271	172	ı	ŧ
37	6	~	55	110	134	170	158	210
38	t	1	1	1	706	706	203	203
39	~	٣	129	270	56	110	•	ı
04	106	901	156	210	138	210	,	ı
. 11	3	m	1	ı	ı	ı	ı	1
42 (trunk up)	706	1 06	ı	ı	1	t	•	•
43	106	901	503	509	•	ı	132	170
ት ተ	114	114	901	106	128	150	901	901
45	55	110	153	210	153	210	<u>س</u>	3
917	901	901	117	130	•	1		1
47	700	901	188	188	225	225	•	ŧ
84	222	222	ŧ	ı	1	1	193	193

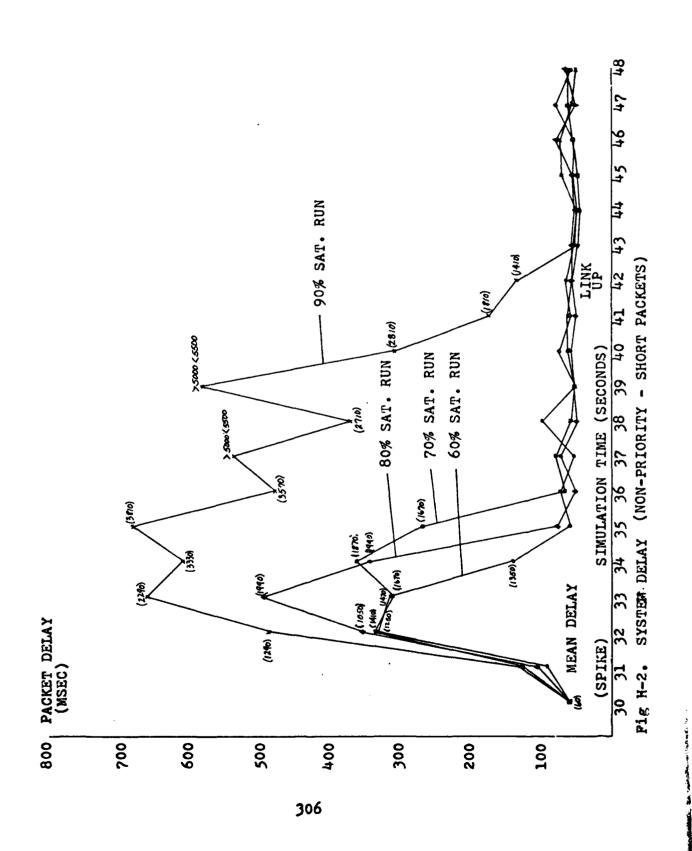
Appendix H

Graphical and Tabular Delay Results

From the Link Loss Runs

Albany - Ft. Detrick Link Loss





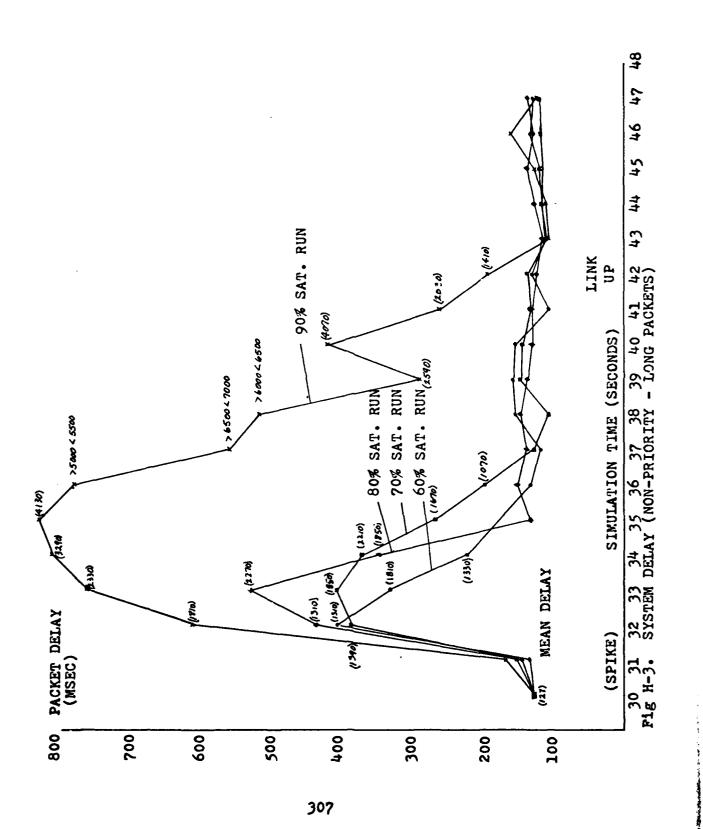


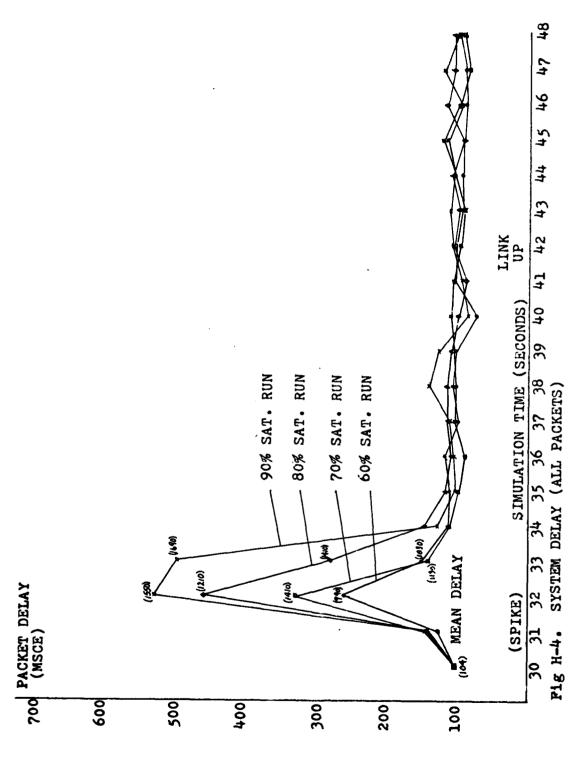
TABLE H-I System Delay (priority - short packets)

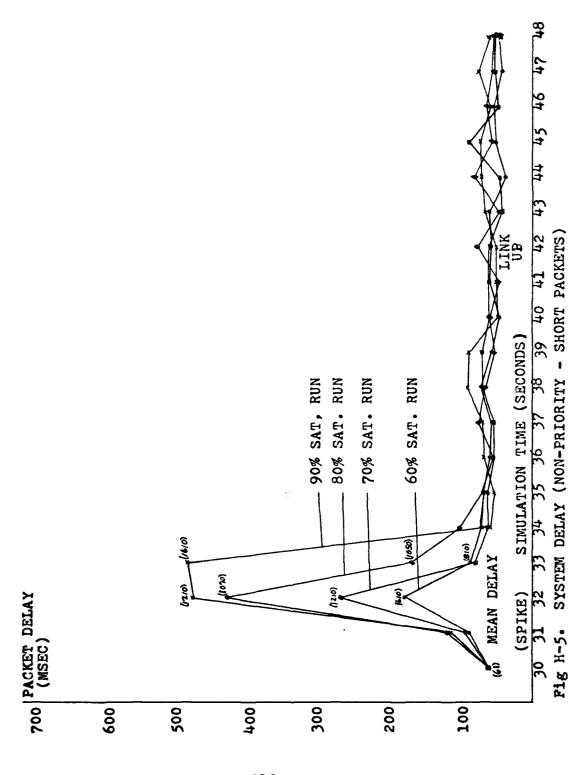
	•		•					
Simulation Times (seconds)	60% Sat. Mean	Delay at. Run Max	Times 70% Si Mean	(milliseconds) at. Run 80% Max Mear	nds) 80% Sat. Mean	Run Max	90% Sat. Mean	Run Max
30	65	230	65	230	65	230	65	230
31 (spike time)		•	48	8	89	190	103	130
32	1		125	150	•	ı	•	ı
33	1		58	28	ω	10	•	1
34	ı		83	83	1	ı	83	150
35	43	43	37	50	90	110	84	48
36	33	33	109	150	64	20	•	ı
37	179	179	J	•		ı	99	190
38	33	33	ı	ı	ı	1		
39	1	1		•	3	٣	35	35
047	99	99	•	1		ı	117	117
17	101	110	•	ı	1	1	ı	ı
42 (link up)	ı	1	~	e	18	30	9	9
43	1	1	٣	9		1	75	110
† †	ı	1	ı	•	ı	1	35	35
45	ı	•	•	1	•	ı	٣	~
94	27	20	1	1	•	ı	•	1
47		t	•	•	ı	1	•	•
817	87	87	9	9	87	87	87	87

TABLE H-II System Delay (priority - long packets)

Simula+ion		Delav	Times (m	lliseco	nds)			
Tines (seconds)	60% Sat. Mean	Run Max	70% Sat. Mean	Run Max	70% Sat. Run 80% Sat. Mean Max Mean	Run Max	90% Sat. Mean	
30	117	370	117	370	117	370	117	370
31 (spike time)	250	250	77	19	124	130	153	310
	226	250	9	ب	•	ı	149	270
33	٣	٣		1	901	901	360	360
₹	120	120	1	,	ı	1		ı
35	ı	,	~	٣	ı	1	506	206
36	100	100	•	•		t	ı	ı
37	206	206	1	1	106	901	148	190
38	242	370	•	1	901	901	259	259
39	112	120	108	190	8	3	ı	ı
. 04	237	237		1	1	1	1	ı
141	13	047	4	4	1	ŧ	526	226
42 (link up)	120	120	209	503	•	ŧ	133	150
143	ı	•	191	210	506	506	٣	m
; ₄ 1	282	290	6	٣		•	ı	•
45	101	190	159	210	184	370	•	1
94	1	1	106	901	ı	1	505	209
47	106	706	•	1	106	106	706	106
84	228	290	33	04	228	290	228	290

Albany - Andrews Link Loss





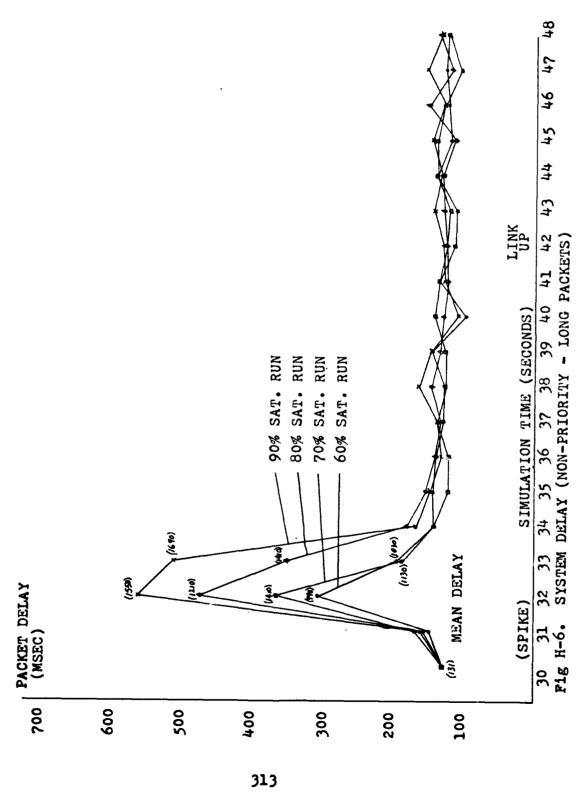


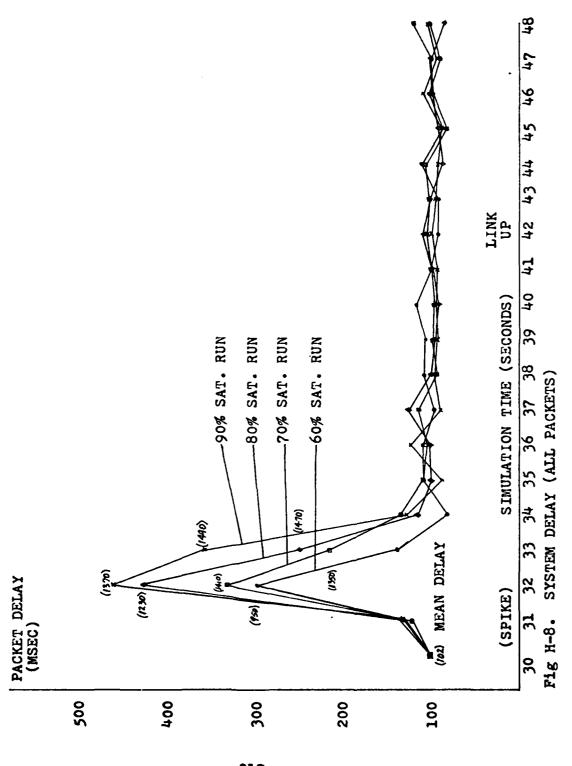
TABLE H-III System Delay (priority - short packets)

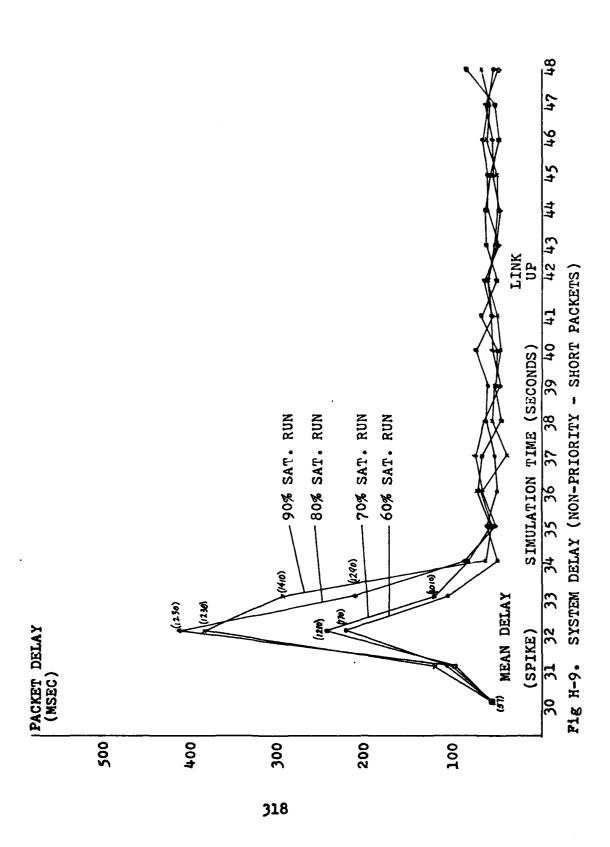
Simulation		Delay	Times	illiseco	nds)			
Time (seconds)	60% Sat. Mean	Run Max	70% S Mean	Run Max	at. Run 80% Sat. Max Mean	Run Max	90% Sat. Mean	Run Max
30	62	230		230	62	230	62	236
31 (spike time)	186	186		90	94	90	85	110
32	89	110		120	1	ı	61	19
33	•	ı		33	3	3	•	1
34	ı	1		ı	1	•	ı	1
35	17	4	1	ı		ı	26	130
36	33	33		90	78	78	•	1
37	38	20		33	52	110	1	,
38	•	ı		ı	33	33	1	1
39	ſ	1	1	1	ı	ı	ı	ì
017		ı	٣	9		ı	1	1
41	í	ı	•	1	•	ı	٣	σ
42 (11nk up)	ı	•	1	1		1	•	ı
643	ı	ı	1	ı	•	,	3	34
44	ı	ı	•	1	33	33	٣	3
45	36	20	•	ı	35	35	33	33
947	23	62	847	847	34	34	9	٣
24	1	ı	13	30	ı	1	9	9
847	33	99	31	80	2	2	ı	ŧ

TABLE H-IV System Delay (priority - long packets)

Simulation Time (seconds)	60% Sat. Mean	Delay Run Max	Times (m. 70% Sat. Mean	illiseco Run Max	Times (milliseconds) 70% Sat. Run 80% Sat. Mean Max Mean	Run Max	90% Sat. Mean	Run Max
30	135	310	135	310	135	310	135	310
31 (spike time)	160	270	56	110	169	390	126	250
32	185	290	1	ı	155	210	158	330
33	ı	t	98	150	2	2	147	290
34	106	106	3	8	706	901	•	ı
35	89	110	1	•	1	i	•	1
36	505	509	ŧ	1	55	110	3	~
37	•	ſ	1	,	106	901	•	ı
	- 106	901	ſ	1	107	190	250	250
39	ı	•	129	270	181	181	•	•
04	508	509	149	270	1	ı	106	901
17	158	210	•	ı	263	263	ı	•
42(link up)	1	ı	209	509	55	110	92	120
43	٣	3	106	901		ı	•	ı
111	62	110	118	130	58	110	146	310
54	92	230	169	230	509	209	3	Μ
94	99	130	6	9	1	4	ۍ	2
47	1	ı	47	47	16	16	•	1
847	106	901	٣	3	ī	t	31	40

Andrews - Hancock Link Loss





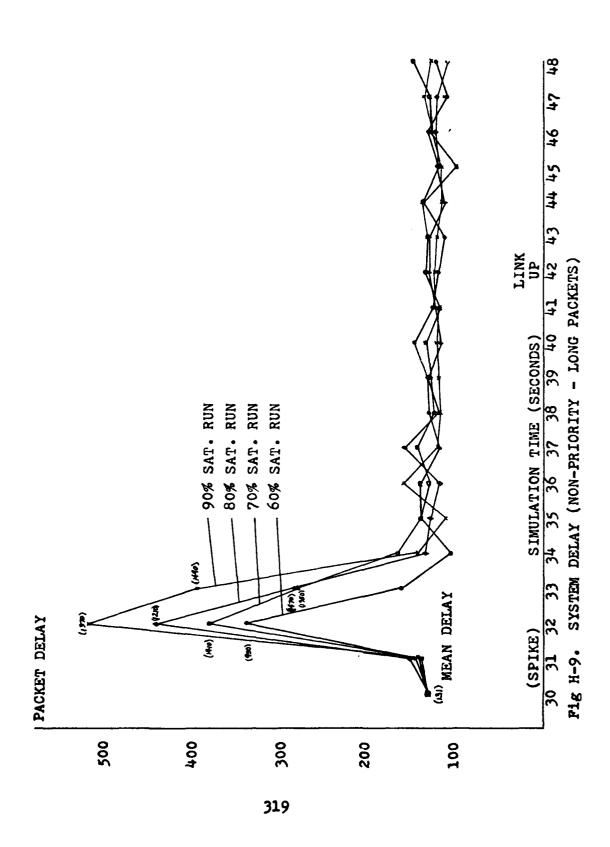


TABLE H-V

System Delay (priority -short packets)

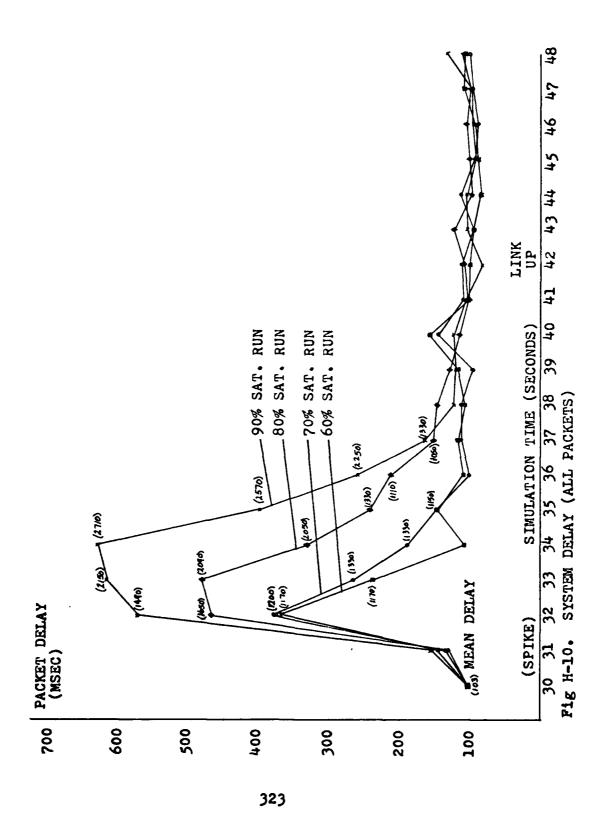
Simulation	7		Times (milliseconds)	illiseco	nds)	Q.	+60 %00	á
Time (seconds)	Nean	Max	Mean	Max	Mean	Max	Mean	
30	122	250	122	250	122	250	122	250
31 (spike time)	47	210	95	170	234	350	96	270
32	901	706	189	290	178	310	•	ı
33	81	110	164	250	٣	<u>س</u>	•	1
34	М	٣	•	1	213	213	~	~
35	1	1	55	110	•		~	٣
36		ı	~	~	c	•	196	270
37	46	150	ı	•	•	1	505	209
38	73	150	116	116	106	210	55	110
39	188	188	225	225	ν,	ν.	•	•
017	181	250	52	110	111	111	9	9
17	t		ı	ı	162	210	٣	n
42 (link up)	•	ı	107	107	901	901	197	197
43	130	130	•	t	200	210	ı	•
111	. 1	1	901	901	193	250	901	706
45	ŧ	1	149	190	•	:		1
94	107	110	208	310	1	1		ı
24	1	1	1	t	c	1	38	20
847	302	302	1		ı	ı	٣	m

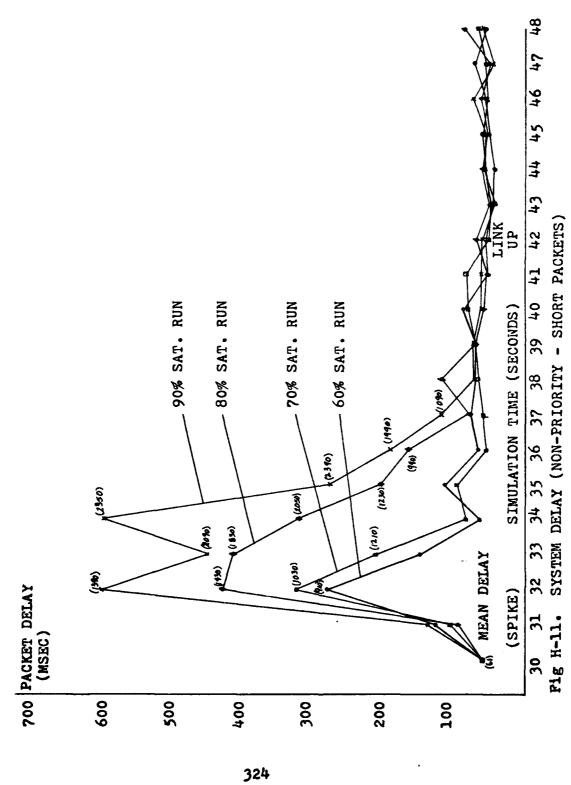
TABLE H-VI

System Delay (priority - long packets)

nulation			Times	illisec	nds)			
Time	60% Sat.		20% S	Run	80% Sat.	Run	90% Sat.	
seconds)	Mean		Mean	Max	Mean	Max	Mean	
30	09	230		230	230 60	230	9	230
31 (spike time)	191	191	٣	٣	111	230	109	130
32	٣	٣	128	128	•	1	75	22
33	1	ŧ	1	ı	52	20	ı	ı
34	•	1	•	ı	٧	ν,	55	20
35	•	ı		ı	21	30	64	64
36	1	t	33	33	i	ı	65	65
37	113	120	ı	1	٣	'n	•	ı
38	33	33	ı	ı	•	•	43	20
39	٣	٣		i	148	230	•	•
. 04	69	20	•	t	ı	ı	•	1
17	1	ı	ŧ	•	ı	ı	63	63
42 (link up)	1	1	ŧ	1	45	45	t	ı
43	63	63	1	•	٣	٣	1	1
44	•	ı	1	ı	ı	•	ſ	1
4.5	79	1 79	ŧ	•	₩8	130	42	20
94	33	33	•		r	ı	33	33
24	20	30	•	;	٣	m	•	•
84	ı	ŧ	6	٣	•	1	176	176

Andrews - Ft. Detrick Link Loss





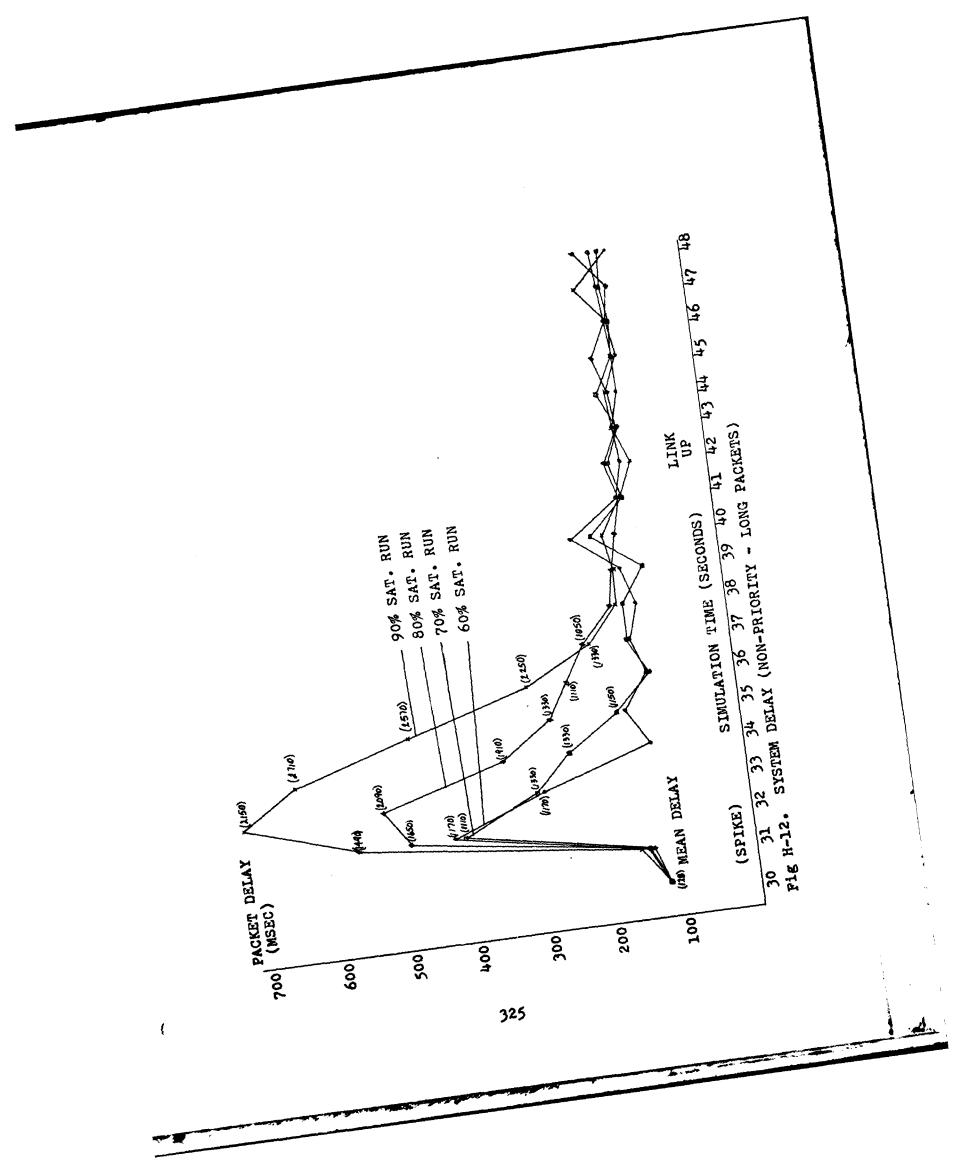


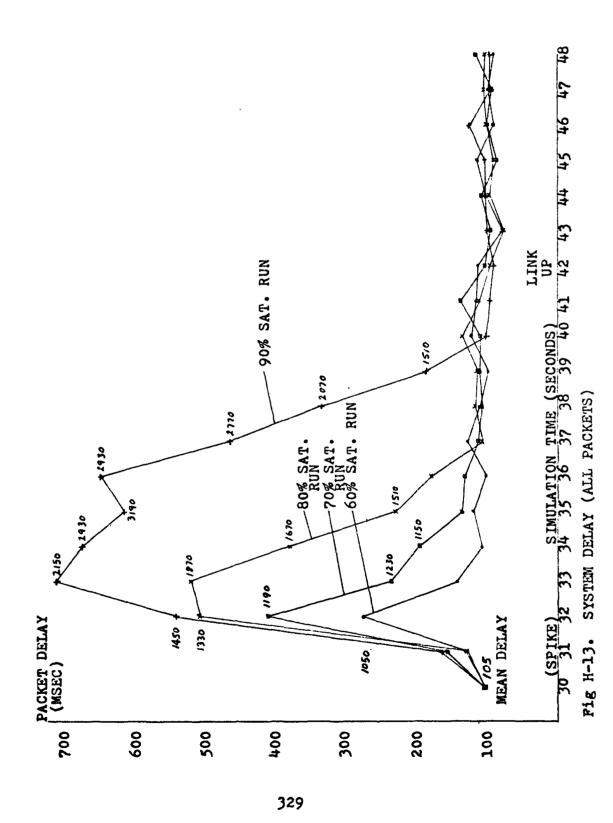
TABLE H-VII System Delay (priority - short packets)

Simulation		Delav	Times	illisec	onds)			
Time (seconds)	60% Sat. Mean	Run Max	70% Sa Mean	Run Max	t. Run 80% Sat. Mean	Run Max	90% Sat. Mean	Run Max
30	1 9		49	230	49	230	119	230
31 (spike time)	96	130	62	110	е.	٣	ı	1
32	82	82	69	210	ı	1	59	59
33	ì	ı	33	33	65	65	•	1
34	ı	•	ı	1	•	٣	80	230
35		ı	i	ı	٣	90	•	ı
36	57	9	33	33	48	42	ı	ı
37	•	1	ŧ	1	47	147	105	130
38	32	50	9	9	41	1	•	i
39	123	123	ı	ı	ı	ı	1	
. 04	18	30	111	111	6	٣	ı	1
41	í	ı	ı	ı	•	1	35	35
42 (link up)	37	37	ı	1	1	i	•	t
43	i	1	43	43	1	1	1	
प्रभ	٣	٣	ı	ı	88	88	63	63
54	•	•	63	63	ı	ı	•	1
917	1	•	33	33	i	ı	ı	ı
24	ı	ı	ς,	٣	48	87	63	63
847	٣	6	54	54	ı	ı	•	ı

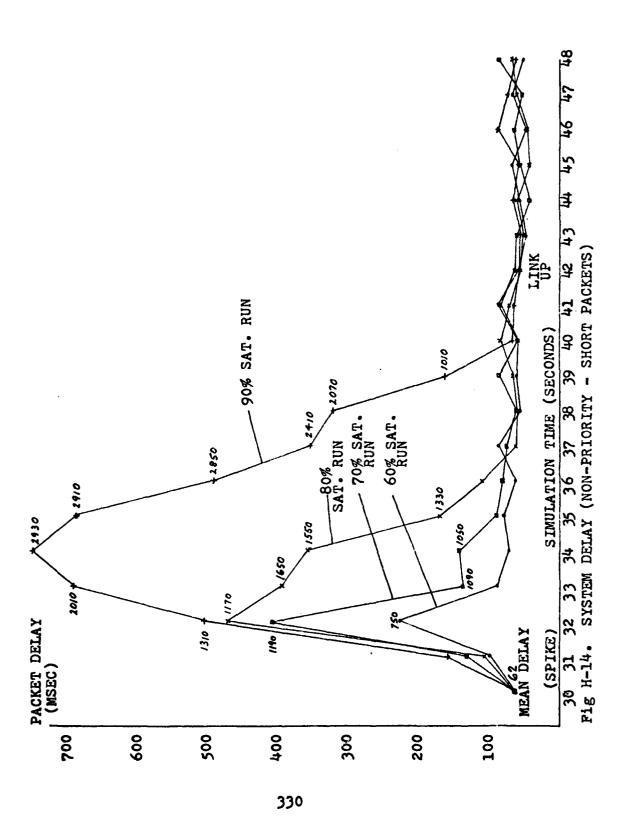
TABLE H-VIII System Delay (priority - long packets)

Simulation		Delay	Times	lliseco	(milliseconds)	ć	7	
Time (seconds)	60% Sat. Mean	Kun Max	70% Sa Mean	Kun Max	80% sat. Mean	Kun Max	yok sat. Mean	Kun Max
30	122	390	122	390	122	390	122	390
31 (spike time)	107	310	153	190	141	370	84	110
32	106	106	ı	1	1	1	294	767
33	٣	m	⇉	10	118	230	ŧ	1
34	901	106	•	ı	101	170	•	•
35	106	901	205	205	106	210	58	110
36	1	1	•	1	•	ı	130	130
37	131	131	•	1	83	130	196	310
38	•	ı	٣	9	133	150	3	٣
39	108	108	55	110	3	٣	•	ı
047	193	193	133	270	901	901	1	1
14	ı	ı	(",	٣	218	218	106	901
42 (link up)	٣	٣	t	t	222	250		ı
643	ı	1	209	209	106	901	•	1
717	ı	ı	ı	ı	210	210	901	106
547	٣	٣	209	209	9	10	200	200
94	٣	٣	4	†	1	ı		ı
24	200	200	209	209	•		108	108
817	106	901	3	9	775	110	1	1

Andrews - Tinker Link Loss



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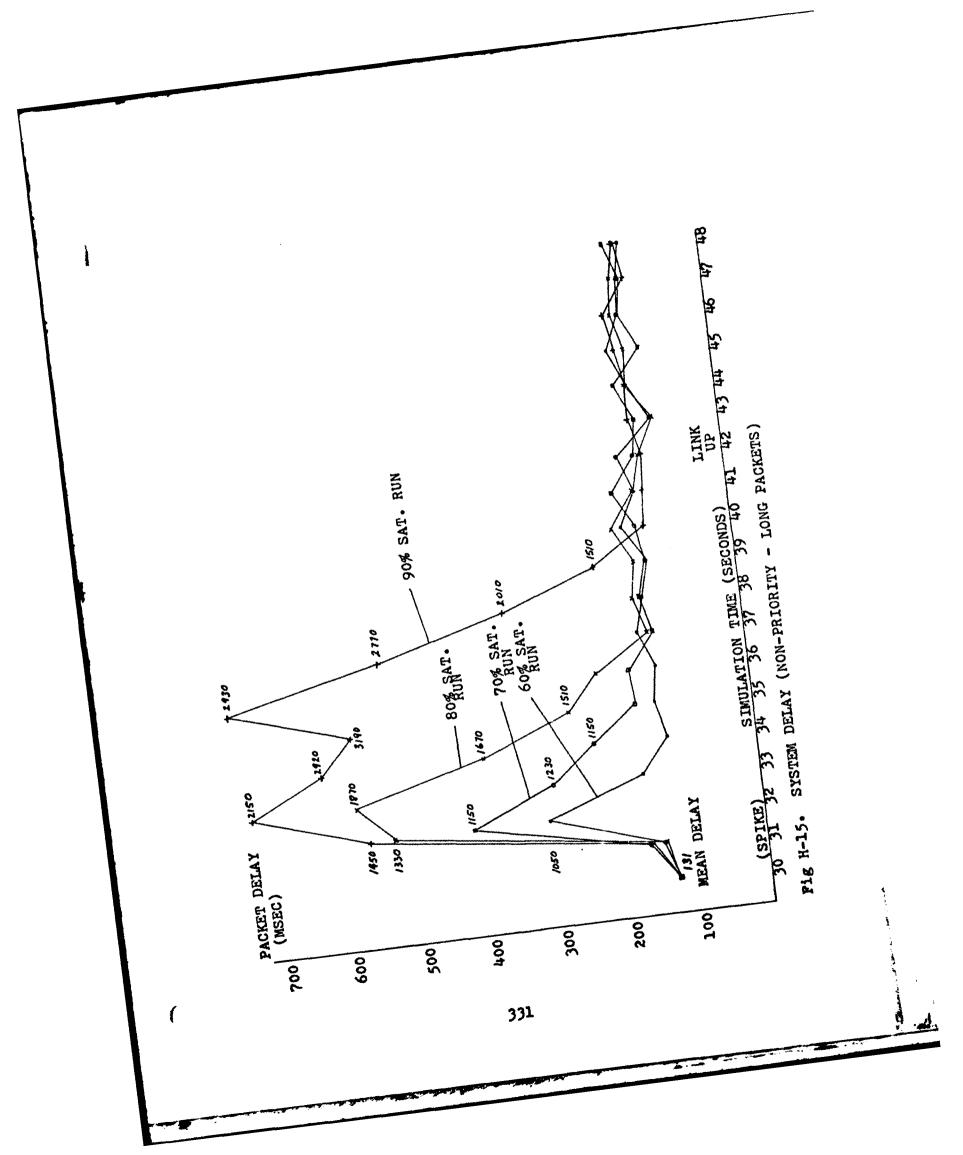


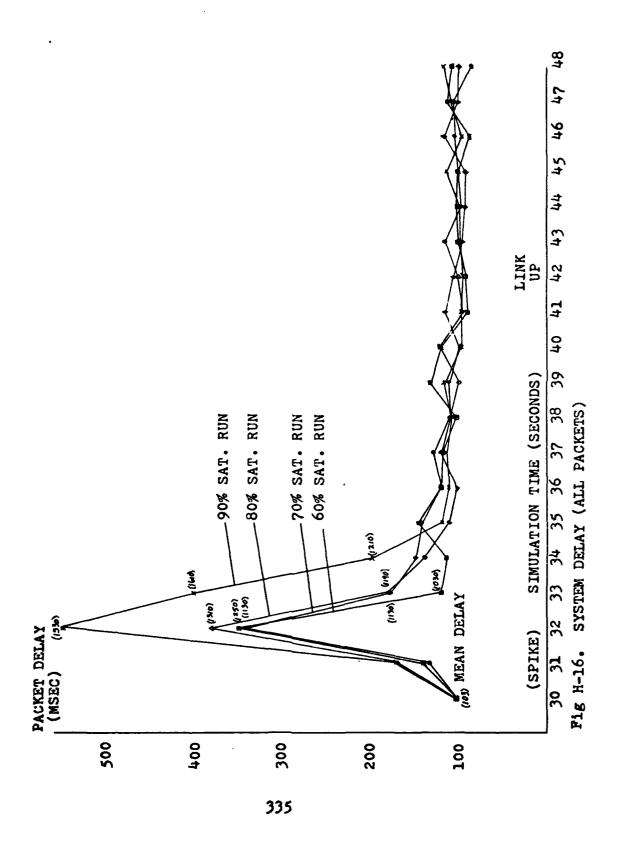
TABLE H-IX
System Delay (priority - short packets)

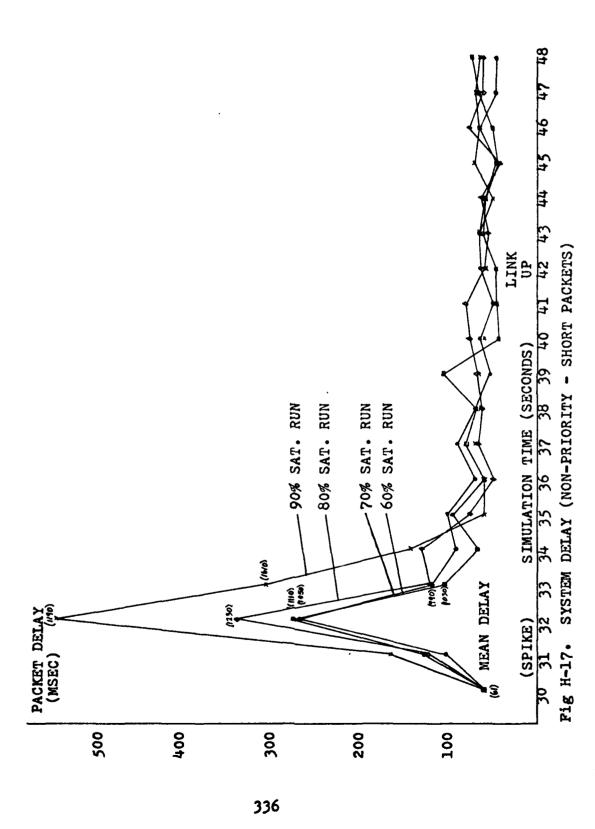
Simulation Time (seconds)	60% Sat. Mean	Delay Run Max	Times 70% Sa Mean	(milliseconds. t. Run 80% Max Mea	nds) 80% Sat. Mean	Run Max	90% Sat. Mean	Run Max
30	62	230	62	230	62	230	29	230
31	26	130	53	96	~	٣	112	112
32 (spike time)	,	ı	ı	ı		1	1	i
33	ı	ı	141	141	~	е	2	2
34	63	63	56	90	1		6	6
35	•	1	2	10	9	9	ı	•
36	647	24	•	t	ı	1	,	ı
37	6	С	٣	٣	,	1	•	ı
38	6	3	٣	٣	ı	•	•	ı
39	,	ı		1	1	ı	,	ı
017	,	ı	ı		ı	ı	121	121
117	,	1	1	•	ı	,	1	ŧ
42 (11nk up)	ı	1	•	•	1	1	63	63
647	33	33	34	34	•	1	•	•
71	1	t	ı	•	•	ı	33	33
547	,	•	•	ı	33	20	σ	٣
917	~	С,	٣	<u>س</u>	~	ς,	124	124
47	74	77	247	47	~	~		ı
84	29	29	ı	ı	1	ı	20	30

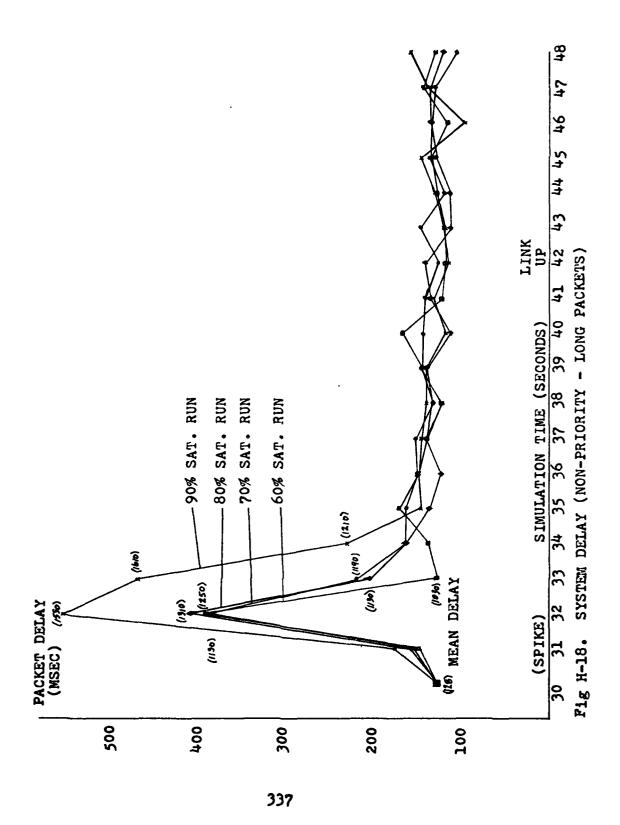
TABLE H-X System Delay (priority - long packets)

Simulation		Delay	Times (m	(milliseconds)	nds)			
Time (secorids)	60% Sat. Mean	Run Max		Run Max	80% Sat. Mean	Run Max	90% Sat. Mean	Run Max
30	127	350	127	350	127	350	127	350
31	202	230	139	170	96	210	1 78	170
32 (spike time)	•	ı	251	390	455	455	180	350
33	134	150	148	290	200	210	316	316
34	210	210	116	230	•	•	503	209
35	257	310	ı		•	1	9	9
36	ı	ı	6	10	•	•	175	210
37	ı	1	509	505	121	230	,	1
38	160	210	1	•	1	•		•
39	٣	٣	132	250	133	133	83	130
017	263	263	89	130	182	310	1	ŧ
141	ı	•	106	901	267	310	38	110
42 (link up)	46	150	144	144	ı	1	6	ω
43	ı	1	108	108	56	110	509	209
717	118	118	209	505	2	2	•	•
45	106	901	509	210	215	215	•	i
94	199	199	1	1	1	ı	106	106
24	509	509	•	1	158	210	107	102
84	•	•	1	•	•	1	٣	~

Gentile - Ft. Detrick Link Loss







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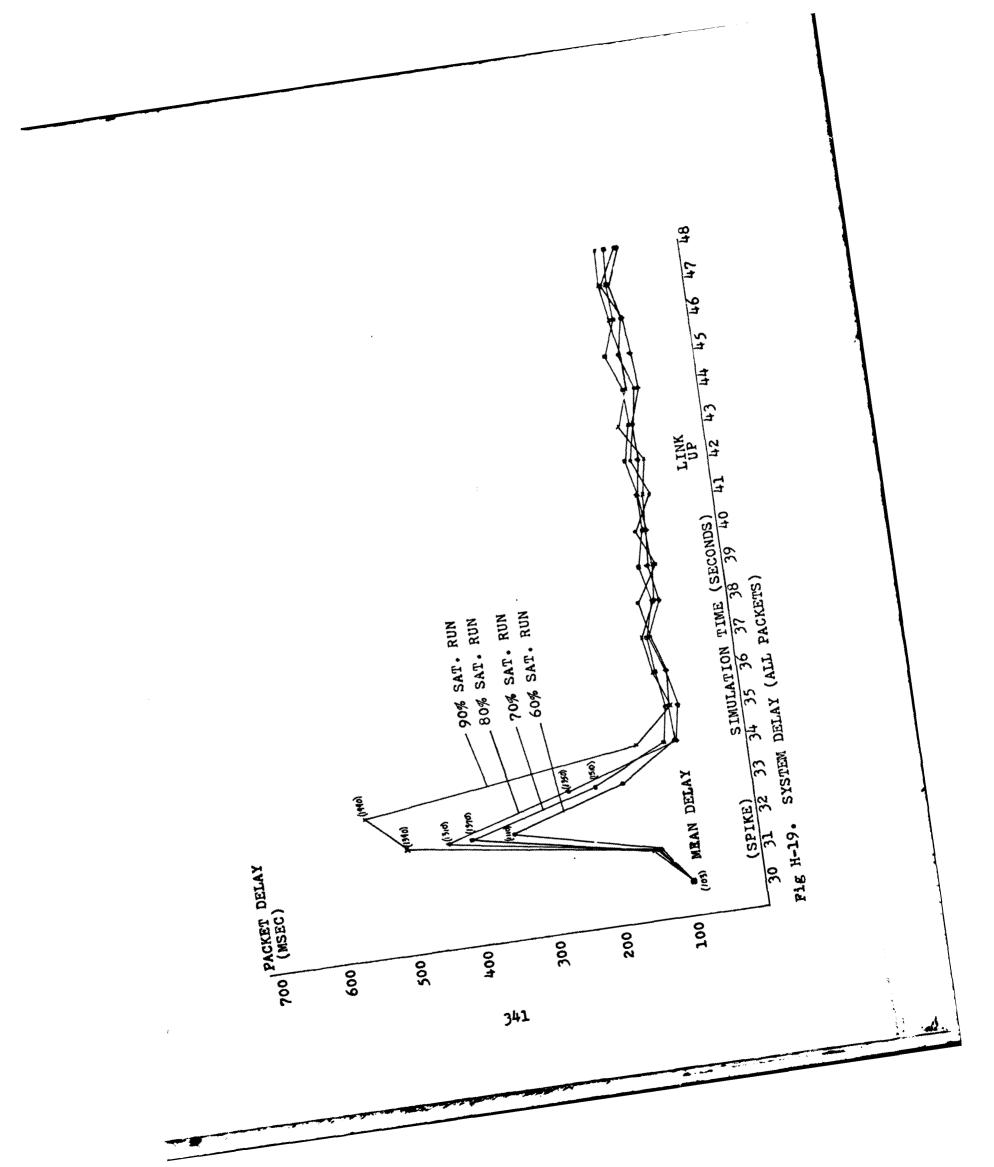
TABLE H-XI System Delay (priority - short packets)

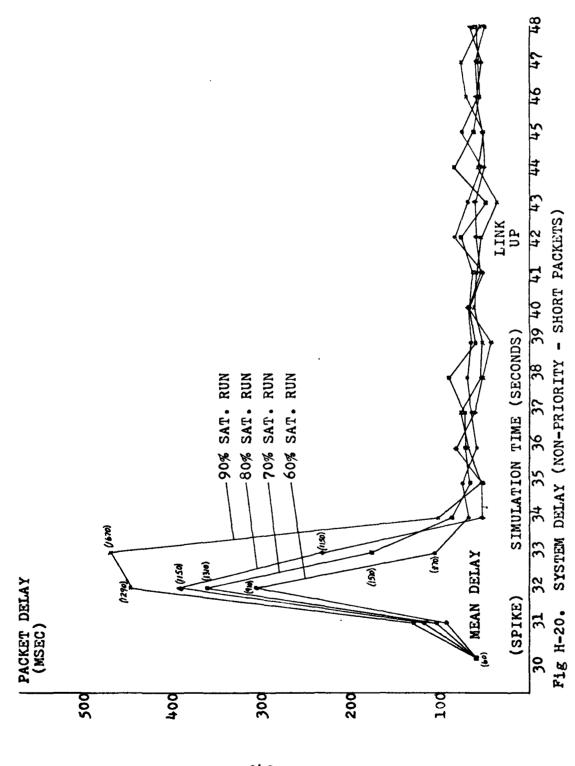
1071070		יים[פת		1111000	יאקס)			
Sinutation Time (seconds)	60% Sat. Mean	at. Run Max		Run Max	70% Sat. Run 80% Sat. Mean Max Mean	Run Max	90% Sat. Mean	Run Max
30	1 9	230		230	1 79	230	1 79	
31 (spike time)	61	110	66	150	77	110	190	210
32	1	1	ı	ı	1	1	ı	1
33	٣	<u>س</u>	1	ı	ı	ı	36	36
74	•	ı		t	1	ı	6	<u>س</u>
35	ı	1	35	35	35	20	163	163
36	٣	٣	ı	ı	•	1	1	1
37	847	20	117	117	89	68	ſ	1
38	80	80	~	9		•	4	#
39	ı	i	ı	1	39	20	1	ı
. 047	35	35	33	33	1	ı	í	1
41	1	1		1	•	ı	1	•
42 (11nk up)	77	ተተ		ı	139	139	108	108
43	ı	ı	179	179	1	t	1	ı
1111	1	•	1	1	33	33	33	33
54	•	1	ı	ı		ı	34	34
917	46	110	18	30	٣	3	118	118
24	35	20	1	ı	٣	٣	٣	~
847	1	ı	ı			ı	•	ı

TABLE H-XII System Delay (priority - long packets)

Simula	tion		Delav	Times					
Time (seconds)	e nds)	60% Sat. Mean	Run Max	70% Sat. Mean	Run Max	80% Sat. Mean	Run Max	90% Sat. Mean	Run Max
30		122	350	122	350	122	350	122	350
31	31 (spike time)	156	250	09	110	98	120	153	330
32		1		ı	1	172	172	ı	i
33		170		1		223	223	235	270
34		99		82	130	92	230	<u>ო</u>	σ
35		255		ı	1		1	185	270
36		286		55	110	t	1	•	ı
37		901		196	196	•	ı	1	ı
38		9	3	183	183	t	ı	٣	3
39		•		٣	٣	~	٣	192	270
040		158	210	43	230	106	106	٣	٣
14		~		٣	<u>س</u>	~	3	ı	ı
745	(link up)	55		•		165	165	1	ı
43			ı	144	150	ı	ı	٣	6
77		1	•	•	ı	•	1	237	270
45		509	290	1		168	230	72	350
94		108	210	٣	٣	163	170	ı	ı
47		106	901	226	350	ı	1	1	ı
817			1	•	•	•	ı		•

Ft. Detrick - Tinker Link Loss





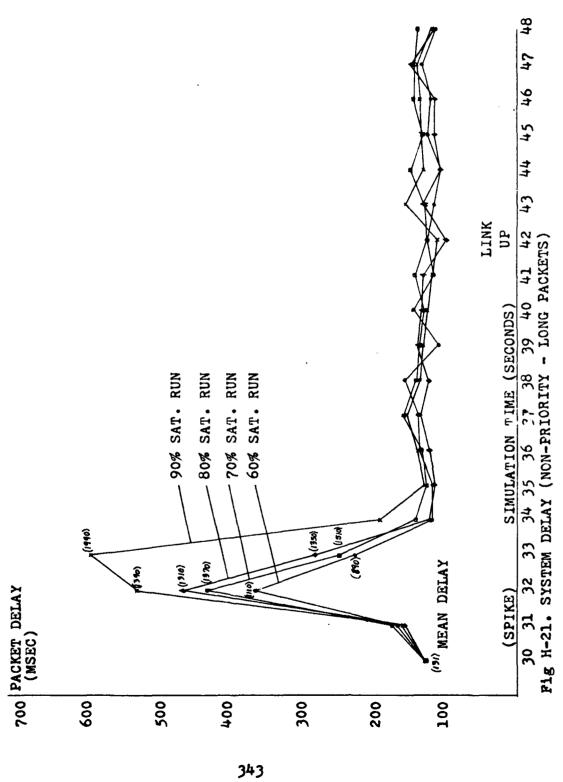


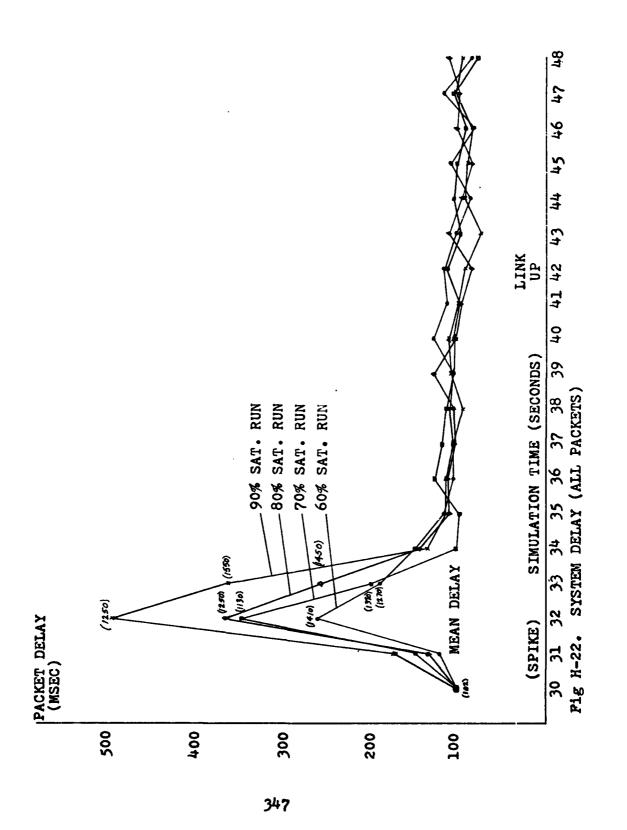
TABLE H-XIII System Delay (priority - short packets)

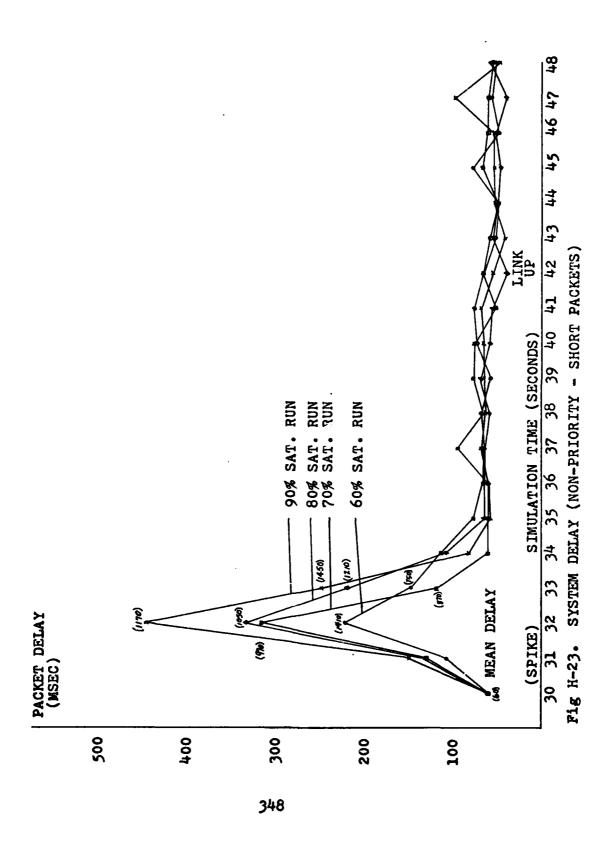
Simulation Time (seconds)	cion ds)	ğĕ	60% Sat. Mean	Delay Run Max	Times (milliseconds) 70% Sat. Run 80% Mean Max Mea	illiseco Run Max	nds) 80% Sat. Mean	Run Max	90% Sat. Mean	Run Max
30		•,	29	230	59	230		230	59	230
31	(spike	time)72	72	120	ŧ	1	31	20	ς,	3
32		•	,	•	169	169	•	ı	1	1
33		V)	38	38	1	ı	1	ı	95	92
34		•	ı	ı	63	63	•	,	37	37
35		.~	82	28	37	37	33	33	•	1
36			81	30	162	162		1		ı
37		v	99	99	~	ς,	ı	,		1
38		ſ	,	ı	33	33	ı	•	53	20
39		•		ı	•	•	•	•	58	58
04	•	•				•	t	J	•	- 1
147		61	33	33	•	•		ı	38	38
745	(link up)	. (dı	•	ı	33	33	•	ı		ı
43			6	٣	ı	:	1	,	•	ı
#		•	ı	1	•	•	4	4	95	92
45			ς.	8	٣	Μ	t	,		ı
947		•		•	105	105	ı	,	37	37
47		~	20	20	63	63		J		1
847		e i	33	33	ł	ı		ı	1	ı

TABLE H-XIV System Delay (priority - long packets)

Simulation		+ 60 % 09	Delay	Times (milliseconds)		nds) 80% Sate	S. S.	00%	Š
(seconds)		Mean		Mean	Max	Ę	Max	Mean	
30		105	230	105	230	105	230	105	230
31 (spike time	e time)	127	150	133	270	128	250	160	370
32		201	390	279	370	113	210	145	250
33		ς.	m	193	210	9	<u>ش</u>	2	2
34		767	762	55	110		ı	,	ı
35		6	٣	211	211	1		901	901
36		•	ı	185	185	106	901	82	150
37		229	229	115	130	95	170	109	150
38		1	1	55	110	209	209	55	110
39		174	174	130	130	160	210	118	130
017		706	706	ı	ı	210	210	•	
41		~	m	1	1	9	9	1	ı
42 (link up	(ďn	•	ı	225	225	1	ı	9	9
43		219	219		í	ŧ	ı	1	ı
71		1	ı	159	159	9	9	52	110
45		•	1	124	190	901	901	121	121
94		140	190	•	1	901	901	122	122
247		1	ı		ı	ı	,		ı
84		•	ŧ	ı	ı	ı		109	109

Gentile - Tinker Link Loss





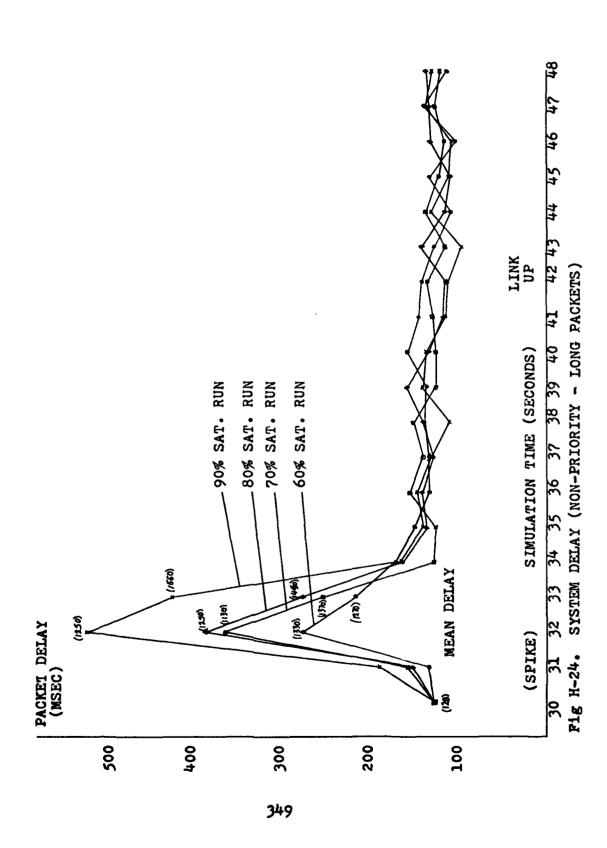


TABLE H-XV System Delay (priority - short packets)

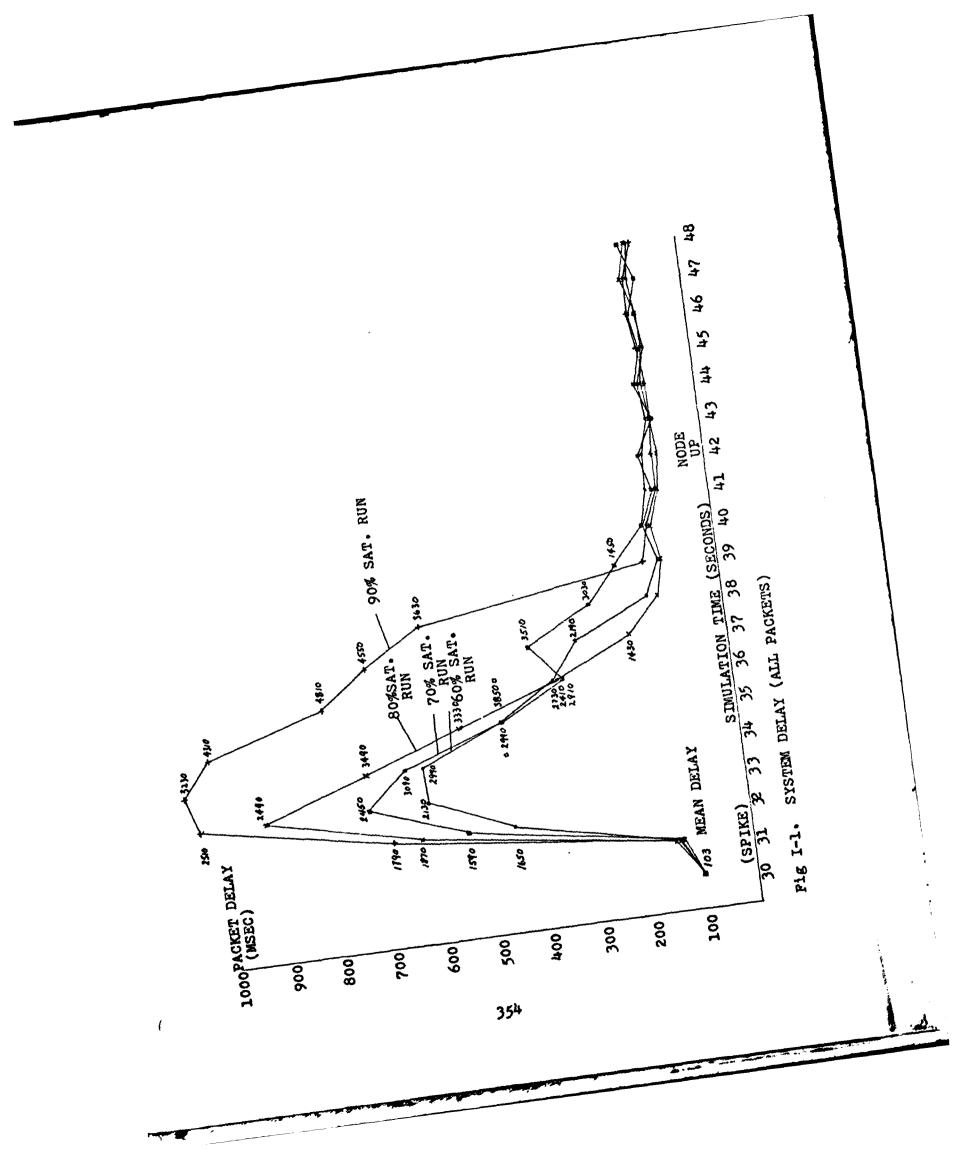
TABLE H-XVI System Delay (priority - long packets)

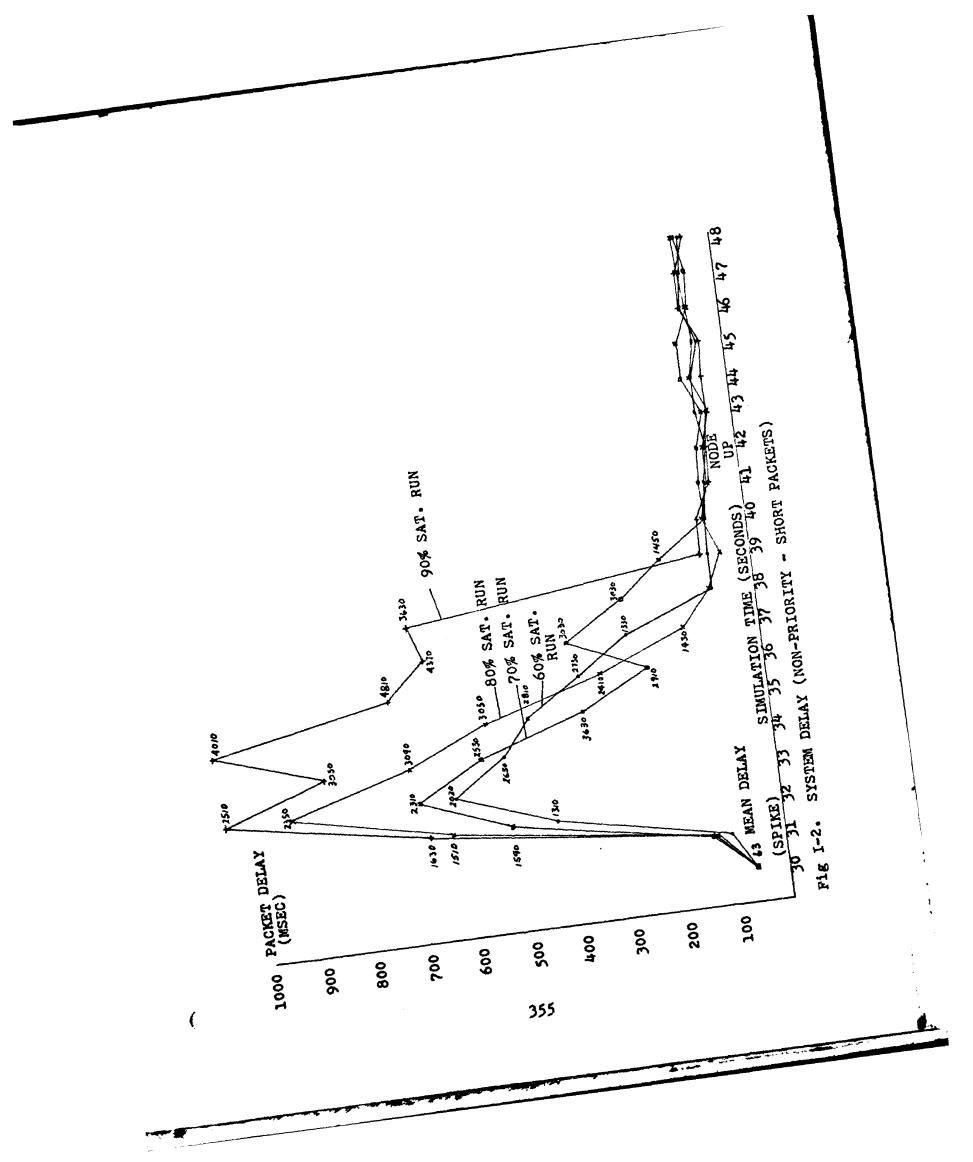
Simulation		Delay		illiseco	nds)			
Time (seconds)	60% Sat. Mean	Run Max		Run Max	70% Sat. Run 80% Sat. Mean Max Mean	Run Max	90% Sat. Mean	Run Max
30	121	350	121	350	121	350	121	350
31 (spike time	109	190	113	330	130	170	125	310
32	ī	•	1	•	236	250	256	290
33	111	111	62	110	147	210	2	2
34	224	350	901	106	505	209	س	σ
35	107	107	901	901	6	٣	107	107
36	٣	٣	1		232	232	11	11
37	901	901	901	706	137	170	141	141
38	87	150	991	210	73	110	48	130
39	106	706		ı	190	210	٣	٣
. 017	140	230	80	110	85	250	158	210
	106	901	<u>س</u>	~	208	210	•	ı
42 (link up)	1	ı	203	203	901	901	1	1
43	211	211	•	1	•	ı	113	113
77	ı	ı	96	190	297	297	95	170
45	188	210	111	210	114	230	106	106
94	706	901	11	H	ı	ı	•	1
24	1	ı	509	209	i	ı	1	ı
84	ı	ı	163	190	901	901	۵۵	Φ

Appendix I

Graphical and Tabular Delay Results
From the Nodal Loss Runs

Loss of Ft. Detrick





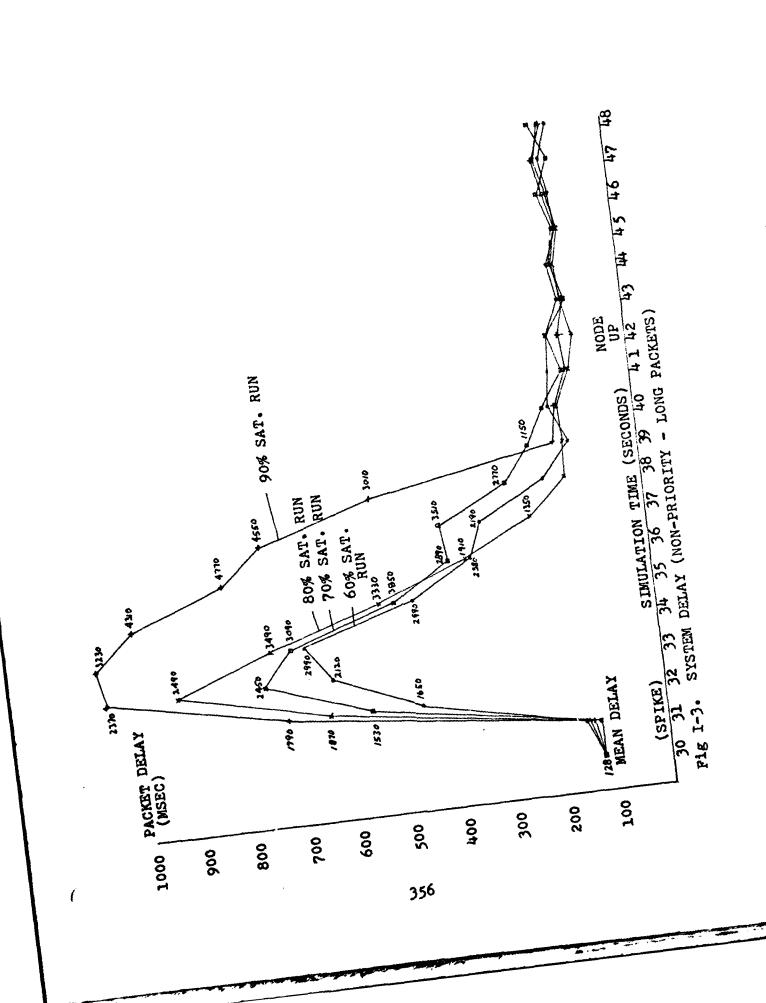


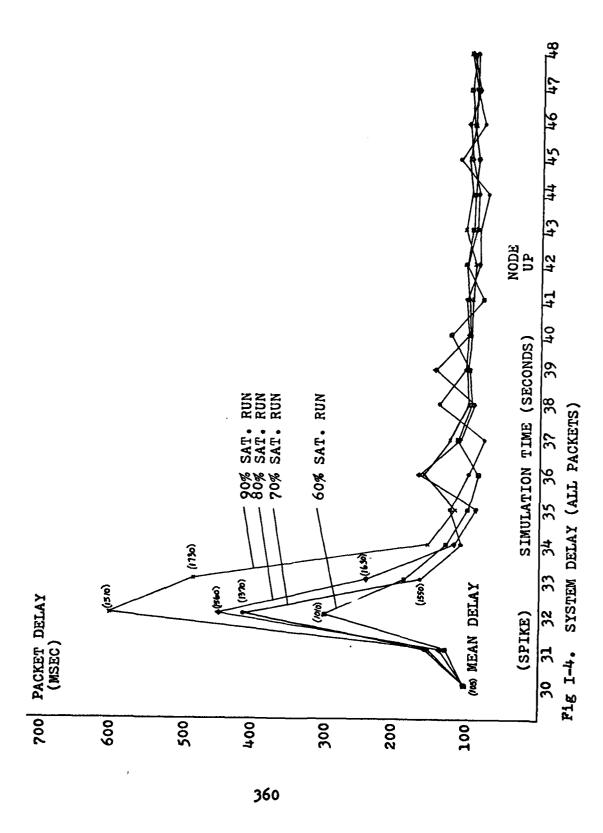
TABLE I-I System Delay (priority - short packets)

Simulation Time (seconds)	60% Sat. Mean	Delay Run Max	Times (milliseconds) 70% Sat. Run 80% Mean Max Mea	illiseco Run Max	nds) 80% Sat. Mean	Run Max	90% Sat. Mean	Run Max
30	69	230	69	230	69	230	69	230
31 (spike time)	106	150	6	3	131	210	93	190
32	•	1	33	33	•	ı	52	52
33	87	130	•	i	•	ı	3	8
34	124	170	1	•	717	77	٣	~
35	ı	ı	<u>ر</u>	6	171	171	80	80
36	35	35	•	•		ı	•	1
37	ŧ	1	t	ı	~	~	1	•
38	1	1	ı	ı	2	2	•	1
39	ı	1	•	t	ſ	ı	1	,
04	t	1	,	ı	i		ı	ı
41	ı	ı	3	е,	33	33	i	ı
42 (node up)	143	143	1	ı	ŧ	ı	94	917
64	ı	1	•	ı	ŧ	,	ı	•
111	ſ	1	ı	,	33	33	35	35
45	1	ţ	٣	٣	~	٣	ı	,
94	t	•	53	20	103	103	1	1
24	39	39	101	101	9	3	1	,
847	1	i	1	ı	1.	i	8	3

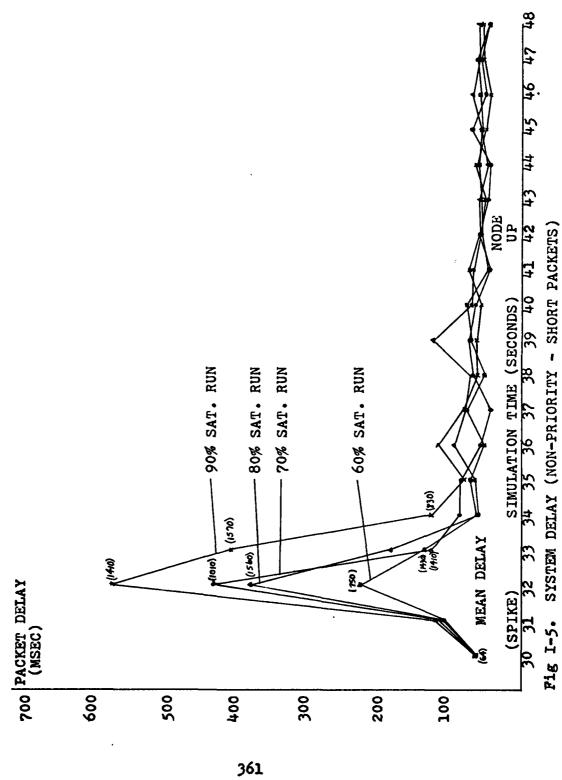
TABLE I-II System Delay (priority - long packets)

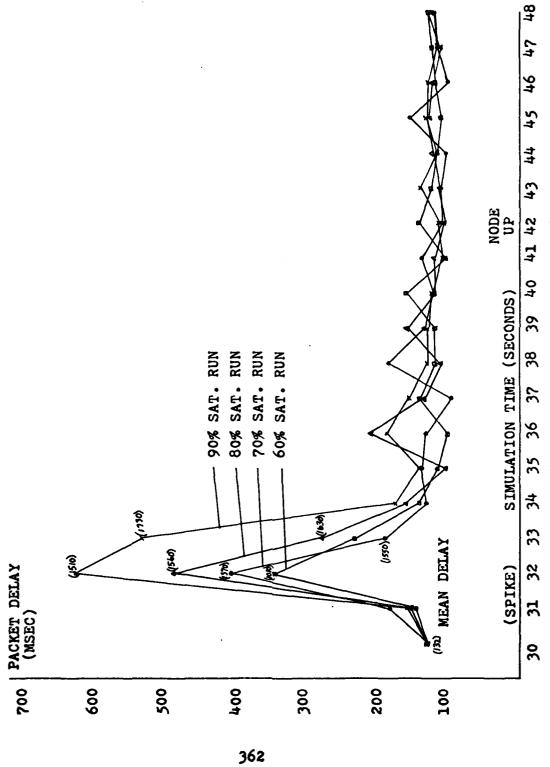
Staulacton		Delay	Times (m	illiseco	nds)			
Time (meconds)	60% Sat.	Run	70% Sat.	Run	t. Run 80% Sat.	Run	90% Sat.	Run
30	113	230	113	230	113	230	113	230
31 (spike time)	66	210	144	310	43	130	186	350
32	ı	ı	343	343	220	350	182	330
33	92	210	150	310	ς,	6	٣	~
34	529	230	131	250	•	ı	•	1
35	6	٣	•	ı	1	•	122	122
36	1	ŧ	232	232	,	ı	308	308
37	12,	230	113	113	195	290	151	290
38	239	370	112	112	62	110	ı	ı
39	115	115	107	107	61	120	147	230
017	149	230		1	ı	1	108	108
147	ŧ	ŧ	11	11	81	210	•	1
42 (node up)	78	130	ı	•	•	ı	•	•
43	1	ı	184	184	56	110	~	~
11	59	110	58	110		٣	t	•
45	106	901	55	110		508	509	209
94	72	110	110	110	363	363	•	1
24	ı	ı	ŧ	ı	186	186	ı	1
847	224	224	ı	•		ı	٣	~

Loss of Gentile



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F18 I-6. SYSTEM DELAY (NON-PRIORITY - LONG PACKETS)

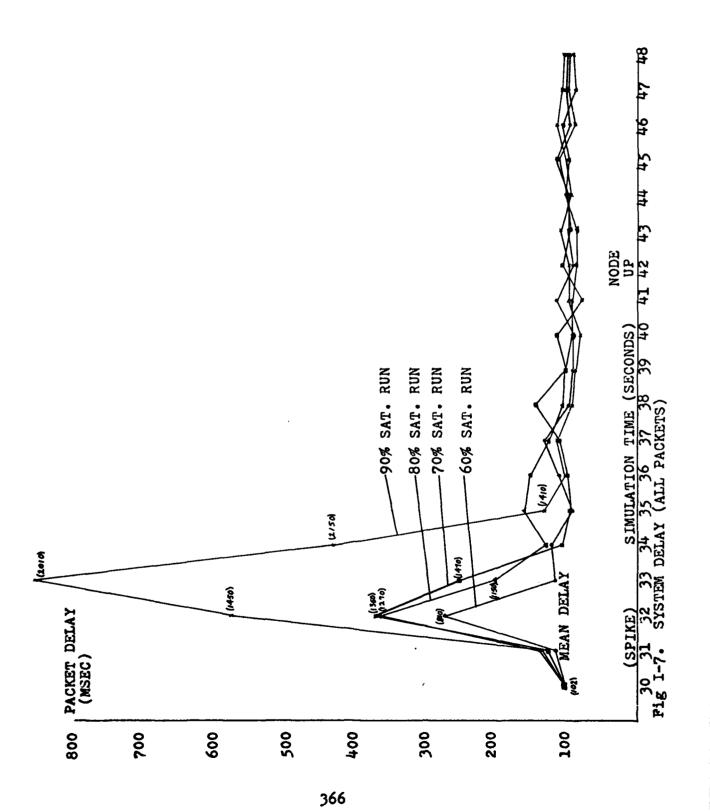
TABLE I-III System Delay (priority - short packets)

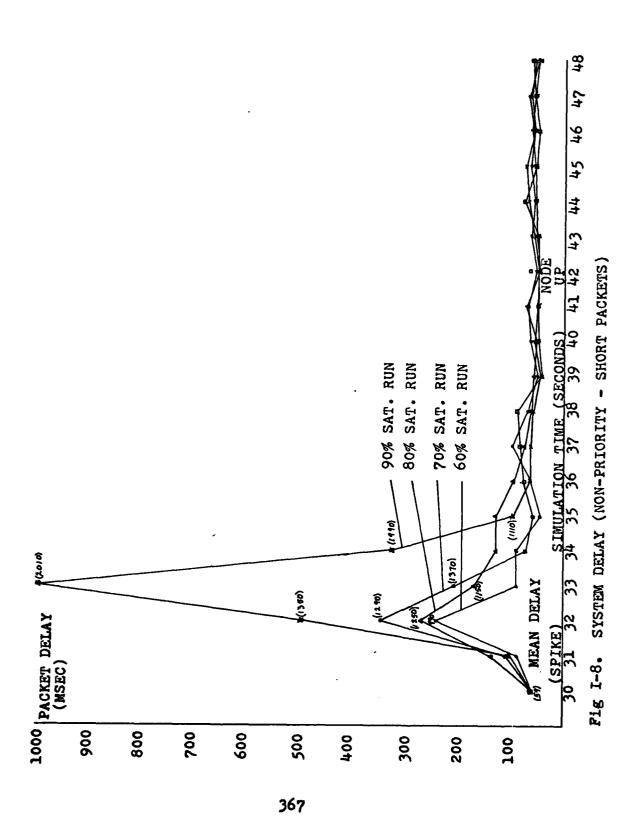
			1	יייייין דר:	1 - 6 - 1			
Simulation Time (seconds)	60% Sat. Mean	Delay Run Max	Times 70% Sa Mean	Run Max	(milliseconds) t. Run 80% Sat. Max Mean	Run Max	90% Sat. Mean	Run Max
30	89		_	230	89	230	89	230
31 (spike time)	9	10		77	65	130	149	149
32	96	96				1	•	ı
33	•	ı	ı	ı	ı	,	208	208
34	•	ı	6	٣	•	1		1
35	•	1		1	77	20	21	30
36	93	93	48	78		1	23	73
37	36	36	33	33	٣	٣	•	1
38	33	33	t	,	64	647	•	ı
39	55	55	1.	1		•	ð	ı
017	23	73	1	•	ı	1	ı	1
141	•	1		•	ı	•	ı	•
42 (node up)	1	1	ı	•	112	112	1	ı
43	1	1	•	•	ı	•	ı	ı
44	1	ı	,	•	1	ı	1	•
4.5		ı		1	29	29	39	39
917	•	•	•	ı	64	20		1
47	33	33	39	39	ı	ı	~	σ
84	ı	1	•	,	•	,	,	•

TABLE I-IV System Delay (priority - long packets)

			ı	•	,					
Simulation Time	tion		60% Sat.	Delay Run	Times (milliseconds) 70% Sat. Run 80% Sat. Mean Max Mean	illisecor Run Max		Run Max	90% Sat.	Run
30	/ en					250		250	116	250
31	(spike tim	ne)	188	310	43	110	154	330	167	170
35	1		•	•	1	ı		174	206	290
33			ŧ		1	•			228	350
*			•	1	1	1		,	141	141
35			٣	٣	106	106	211	211	706	106
36			•	1	9	9		901	210	310
37			107	210	1	•		•	158	210
38			1	ł	219	219		110	509	209
39			ı	ı	108	108		7	9	٣
70	•		•	•	213	213		110	•	•
14			•	1	592	566		901	٣	٣
775	(uode up)		1	ı	ı			1	•	ı
43			•	1	188	250	ŧ	1	ı	•
71			,	t	ς,	3		•	52	110
45			س	٣	37	110	٣	٣	151	190
94			184	310	23	110	257	257	•	1
47			ı	ı	199	199	110	110	223	223
847			•	ı	•	1	ı	1	109	110

Loss of Tinker





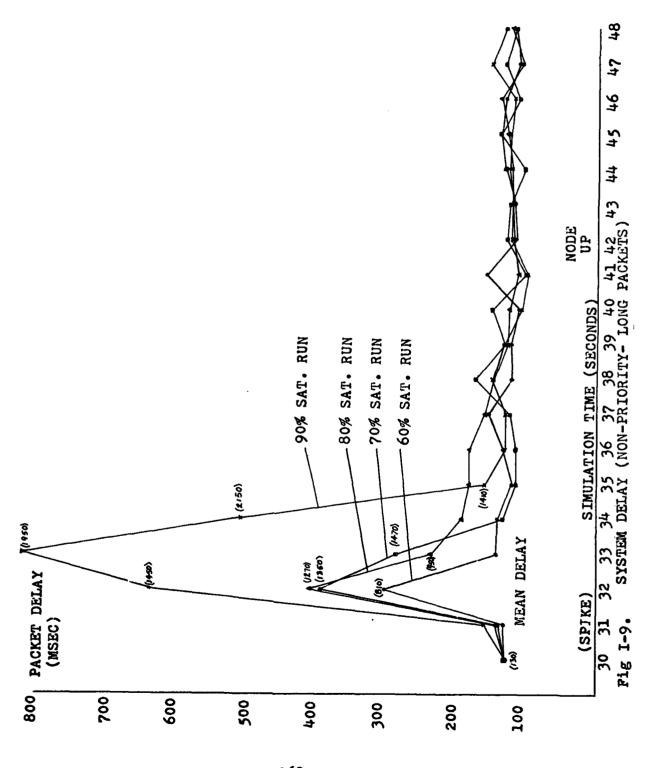


TABLE I-V System Delay (priority - short packets)

Simulation		Delay	Times (m	illiseco	nds)			
Time (seconds)	60% Sat. Mean	Run Max	70% Sat. Mean	Run Max	70% Sat. Run 80% Sat. F Mean Max Mean	Run Max	90% Sat. Mean	Run Max
30	62	230	62	230	62	230	62	230
31 (spike time)			62	130	111	210	4	4
32	120	120	138	138			•	•
33	1	1	ı	•		ŧ	52	25
34	1	•	ı	1		1	1	
35	88	88	ı	1	9	9	160	160
36	•	ı	98	98	t	ſ	35	35
37	1	ı	1	•	ı	\ f	ı	1
38	1	•	1	1	1		•	ı
39	1	1	1	•	•	f	ı	•
017	33	33	-	1	ı	ſ	ı	•
143	т	6		•	1	í	ı	•
42 (node up)	ı	1		•	ı	í	•	ŧ
43	33	33	1	•	•	ť	i	ı
क्ष	143	143	1	t	152	152	•	ŧ
45	ı	ı	ı	ı	43	43	72	72
94	ı	,	119	119	<u>س</u>	٣	ŧ	1
47	80	130	•	ı	1	1	•	ı
84	33	33	9	9		•	1	1

TABLE I-VI System Delay (priority - long packets)

Simulation	+00 %07	Delay	Times	(milliseconds)	nds)	ä	00% Sat	R
Time (seconds)	Nean	Max	Mean	Max	Mean	Max	Mean	
30	106	350	706	350	106	350	706	350
31 (spike time)	1	1	108	210	168	270	9	110
35	129	210	128	128	544	544	135	170
33	ſ	ı	55	110	•	ı	•	,
*	112	120	133	150	128	128	•	ı
35	•	:	9	m	ı	ı	4	4
36	209	509	•	ı	,	1	1	,
37	ı	1	209	209	ı	,	195	195
38	•	1	184	250	J	1	187	210
39	174	210	•	i	٣	9	ŧ	,
. 04	æ	89	1	17	•	1	•	ı
17	6	ς	ı	ı	,	•	ı	1
42 (node up)	106	901	132	132	ν,	У	1	•
	i	1	ι	ı		•	108	110
ተ ተ	ı	ı	109	210	1	1	95	190
45	106	901	113	210	148	230		ı
94	134	150	191	210	6	3	114	114
24	ı	ı	106	106	•	ŧ	ı	ı
84	œ	œ	ı	ı	ı	ŧ	ŧ	ŧ

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Computer Communications Network AUTODIN II Routing Algorithm Packet-Switching Center

ABSTRACT (Continue on reverse side if necessary and identify by block number)

A general overview of the AUTODIN II computer communications network is given. The proposed hierarchical routing algorithm is discussed with detailed explanation of each of the six modules. The GPSS simulation language is discussed with particular emphasis on how it was used in the simulation program to model the AUTODIN II network. Examples of various computer simulation runs are given with detail on how the program was changed to simulate the various traffic volume changes and network topology changes. An analysis section discusses

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packet delay and defines two parameter which are used to determine the adaptability of the routing algorithm. The report concludes with conclusions on the algorithm's ability to adapt to traffic volume fluctuations and network topology changes. Recommendations on further simulation exercises and possible changes to network connectivity and to the routing algorithm itself are also given in the last section.

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